REVIEW OF EDUCATIONAL RESEARCH

Official Publication of the American Educational Research Association, a department of the National Education Association

The contents of the REVIEW are listed in the EDUCATION INDEX.

Volume VIII **October 1938** **Number 4**

The School Plant and Equipment

Reviews the literature from April 1935 to April 1938

Prepared by the Committee:

T. C. Holy, *Chairman;* William E. Arnold, N. L. Engelhardt, and H. H. Linn,

with the cooperation of:

Henry H. Bormann, W. W. Carpenter, M. M. Chambers, Blake Cochran, N. L. Engelhardt, Jr., Ray L. Hamon, R. W. Hibbert, C. D. Hutchins, Edgar L. Morphet, H. W. Schmidt, Howard Dwight Smith, Tracy F. Tyler, and N. E. Viles.

Table of Contents

Part I

STUDIES RELATING DIRECTLY TO SCHOOL BUILDINGS

Part II

INTRODUCTION

THIS IS THE THIRD NUMBER of the *Review of Educational Research* to deal with the school plant and equipment. The first number was issued in December 1932. The second, issued October 1935, was expanded to include individual chapters on methods of determining housing requirements in elementary schools and junior and senior high schools; heating, ventilation, and sanitation; playgrounds; school plant insurance; types of construction and materials as related to the original cost, maintenance, and operation of school buildings; recent trends in school plant planning; and needed research in the field of school buildings and equipment. Certain of these topics had been treated in a single chapter in the first issue.

This third number follows the general plan of the second, with a few changes. Chapters dealing with methods for determining housing requirements, playgrounds, insurance, types of construction and materials as related to cost, and recent trends in school plant planning, have been omitted because it was the Committee's judgment that there was not enough new material to warrant including such chapters in this number. Probably in the next issue some of these topics should be treated again. The present issue contains chapters on the following topics which have not been previously treated in separate chapters: schoolhouse lighting, cost of school buildings, school plant development in foreign countries, technics of school building surveys, pupil transportation equipment, state studies of local school units as related to the school plant, trends in school architecture and design, and significant court decisions in the school plant field.

Basic research in this general field is not abundant. The writer is glad to report, however, that some headway is being made, the details of which will be found in the last chapter.

T. C. HOLY, *Chairman,*
Committee on the School Plant and Equipment.

CHAPTER I

Operation and Maintenance of the School Plant[1]

H. H. LINN and TRACY F. TYLER

Introduction

A SURVEY of the literature in the field of school administration appearing since April 1, 1935, revealed few books, but numerous articles, dealing with various aspects of the operation and maintenance of the school plant. A careful study of these articles disclosed a general lack of objective research in this area, although opinions are expressed freely.

In preparing this chapter use was made of the *Education Index* and a careful examination was made of all issues since April 1, 1935, of the following periodicals in the school administration field: *The American School and University*, *The American School Board Journal*, *The Catholic School Journal*, *Educational Abstracts*, *The Journal of Education*, *The Model Custodian*, National Council on Schoolhouse Construction *Proceedings*, *Nation's Schools*, National Association of Public School Business Officials *Proceedings*, *School Business Affairs*, *The School Executive*, and *School Management*. In addition, files of *Buildings and Building Management*, a periodical serving the commercial building field, were canvassed for articles which might have application to school building operation and maintenance.

Personnel

Selection—Efficient operation and maintenance of the school plant depend largely on the type of personnel employed. Definite plans and criteria for the selection of custodian-engineers are lacking in the majority of school systems. Benbow (9) found in a questionnaire survey which included 141 replies from 34 states that of 19 separate factors upon which selection was based, the personal interview was used by the largest number (81 percent), and an intelligence test by the fewest (8.5 percent). A medical examination, which the author believed to be fundamental, was required in only 30 percent of the cities. The amount of formal schooling was considered in only 22 percent of the cities. Articles describing the methods in use in their own school systems were written by E. E. Allen (5), Flikeid (43, 44), Lamb (65), Linn (73, 74, 75), and Stevenson (125).

Training—The pioneering work in the training of janitors, engineers, and custodians, begun in Minneapolis, has resulted in an increased attention in all parts of the country to the importance of this problem. Womrath and Helm (153) described the twenty-six months' course offered in Minneapolis, and Viles (141, 142), the statewide training system set up in Mis-

[1] Bibliography for this chapter begins on page 466.

souri under the auspices of the state education department, where separate centers were established in cities and teacher-training institutions. The teaching in Missouri consisted of four steps: (a) specialist gives lecture and demonstration; (b) janitor-teacher outlines problem to class or group; (c) men do the job under supervision; and (d) group discusses questions pertaining to various methods of doing the job. Beswick (12) announced two schools conducted by the University of California for the training of instructors in this field. Mahone (91) described the work of the four-day school given at Iowa State College to the more than four hundred in attendance. A summary of the lectures given at the three-day conference at Michigan State College in June 1936 is available (22).

Work schedules—Some attention is being devoted to an analysis of the custodian's duties and to the development of reasonable work schedules. WPA workers conducted a survey in Alhambra, California (124). Five points were covered: (a) a time and motion study of all operations being done by each custodian over a period of several days; (b) a study of all of the operations that should be performed in each section of the school plant; (c) a study of the frequency with which each operation should be repeated; (d) a determination of the man-power necessary to do the required amount of work in the given time; and (e) a detailed schedule of work for each custodian, based on the findings of the study. Cook (24) cited six steps in the effective utilization of man-power. Grabarkiewicz (49) discussed work schedules and illustrated an example. Other discussions of the work schedule were presented by Joyner (59), Fisher (37, 38), Alexander (2), Christianson (19), Pearson (100), and *School Management* (21).

Salaries—The National Education Association studied the salaries paid school custodial employees. Carr (16) found that salaries increased with the size of city. The severe reduction in salaries caused by the depression fell no heavier on custodial employees than on any other group of school employees. *Nation's Schools* (149) presented salary figures for St. Louis and Detroit. Saylor (117) summarized the results of a survey of Nebraska public schools made by the Nebraska State Teachers Association for the year 1936-37. He covered the number of months of annual employment, the number of custodians employed, the annual salaries, and the like. He found that many schools secured neither a high type individual nor a well-qualified man. Only 37 percent received $75 or more per month. He asserted that schoolboards should use the same care in selecting custodians as in selecting teachers.

Working conditions—Linn (71) concluded that sooner or later school custodial and maintenance employees would be affected by current trends in the labor movement. In his opinion labor is asking for: (a) fair wages, (b) reasonable hours, (c) decent working conditions, (d) fair and decent treatment, (e) reasonable security, (f) retirement provision, (g) privileges—vacation, sick leave, and holidays. He believed these to be legitimate demands that should be granted. Kelly (60) discussed the human factor in

establishing the proper relationships between the custodial staff and the school children and faculty. He emphasized the importance of the custodian in the education of the pupils. In another article, Linn (70) pointed out the many areas in which the custodian has responsibility and argued that the competent custodian is a skilled laborer and ought to be paid proportionately.

Supervision—Consistent and regular inspection of the work of custodial and maintenance employees is essential to the protection of the enormous capital investment and to the maintenance of high standards of service. Pykoski (105) discussed the items which should be considered in making an inspection of engineering service and presented an inspection and rating score-card. Womrath and Campbell (152) described the visible record system maintained in the Minneapolis schools. Flikeid (41) presented necessary forms and described a system of inspection and rating of janitorial service. Alexander (3) considered supervision to be the "toughest" assignment of all and gave a number of points learned from his experience as manager of a large commercial building. Johnson (58) gave a detailed description of a system of supervision and inspection in a university plant. He concluded that successful plant operation was dependent upon the efficiency of inspection coupled with the prompt and effective following up of all unsatisfactory conditions revealed.

Dress—Writers on the subject agreed that the use of uniform dress for custodial employees tends to raise the standards of custodial service. Robertson (115) contended that a uniform will do much even for the crabby, drab custodian. Linn (77) noted a number of advantages to be secured from uniform dress, among which was the increased respect which is engendered among pupils, teachers, and the public generally for the employees. His criteria for selecting garments were: (a) comfort, (b) attractiveness, (c) durability, (d) safety, (e) ease of cleaning, (f) adaptability, and (g) economy. *The Model Custodian* (101) also listed a number of points on personal appearance.

Housekeeping

Articles concerning housekeeping predominated in the literature covering the field of operation and maintenance of school plants. Most of them described practices which had grown out of the experience of the writers. A few were based on scientific studies. Rightmire (114) described an experiment in which cleaning room walls increased the illumination 29 percent. *School Business Affairs* (122, 148) presented the consensus of members of the National Association of Public School Business Officials with regard to a few cleaning problems. Terrazzo floors should be scrubbed no more than absolutely necessary and then only with a mild or neutral soap solution with the immediate removal of surplus water to prevent absorption. One suggested method for keeping them clean was the use of a thirty-six-inch push broom with stiff bristles over which is placed a damp tubular

mop cloth. A real effort was being made to get most of the custodial work done during the day. The apparent general practice was for some men to work from 7:00 A.M. to 3:00 P.M., and others from 1:00 P.M. to 9:00 P.M. Mitchell (93) found the school maid best at cleaning classrooms. Pykoski (108, 109) and an article in *Nation's Schools* (139) described several methods for washing walls and ceilings. No more cleaning agent than is required should be used. This should be determined by test, being repeated for every room and for every surface. Clark (20) found that keeping the dirt out of the building saved one-fourth of the cleaning. This can be done by surfacing the playgrounds, keeping the walks clean, providing scrapers and mats at all entrances, supervising all entrances, and by calking and weather-stripping the building. Warren (144) concluded that suction cleaning was the ideal method for a school building. He believed the trend to be toward heavy-duty, portable equipment. His conclusions did not agree with *The Model Custodian* (129, 130) in which a treated sweeping mop was advocated, or with Currington (28) who advocated spraying the treatment on the floor and then using an untreated dust mop for sweeping. Neither did his method agree with that used in Rockefeller Center (32) where 1,800,000 square feet of floor space are cleaned nightly. The Oregon Department of Public Instruction (135) advocated cheese cloth or loosely knit material for dusting flat surfaces and soft woolen or cotton yarn fastened to a frame with a handle for vertical parts of desks. Oil or chemical treatment and not water should be used on dusters. The use of electric machines rather than hand scrubbing for floors is generally agreed upon. Another article (120) cited eight advantages of machine scrubbing over manual scrubbing.

Floor Maintenance

Hard maple, because of its wearing qualities, was generally conceded to be the best type of wood for classroom floors. Further conclusions, drawn from the literature in the field, are that the treating of wood floors with mineral oil is passing from favor, that penetrating preservatives which seal the floor surfaces are gaining in popularity, and that the use of treated push mops for the daily cleaning of floors produces superior results.

The revised edition of Longshore's book (78) contained helpful information and suggestions with regard to the treatment of various types of floors. The author's relationship to a company manufacturing products for use on floors may, however, have prejudiced his suggestions relative to the specific proprietary products to be used. Longshore (80) also presented some of his suggestions in briefer form. Flikeid (40, 42), as well as other writers, uttered warnings against the use of water and scrubbing mixtures on varnished or sealed floors. The use of good bakelite treatments to seal wood floors has the almost unanimous approval of men who have made a study of the problem. Schultz (119) discussed some of the dangers in the use of bakelite floor finishes and noted the necessity of ample ventilation

from below to prevent the warping and decay of the floor. A number of articles described the preparation of an old wood floor for modern methods of maintenance. Busby (14), Wright (155), and Linn (76) presented their approved methods. Brubaker (146) opposed waxed floors in rooms occupied by younger children. She noted the danger of falls, the increase in tension in both children and teachers caused by the fear of falling, and believed such floors might be a contributing factor in speech difficulties. Water emulsion waxes are replacing the spirit waxes in many places. They were favored by many commercial building owners and managers (7) as well as by Benson (11), Longshore (79), Wells (147), Casey (17), and others—but such favor was not unanimous.

Heating

McCullough's study (83) is the outstanding contribution in the field of fuel management in schools. The study developed two procedures: (a) an analytical procedure to be used in evaluating completely the fuel management problem in any school system; and (b) the practical application, which gives ways of improving the conditions discovered. The evaluation was divided into three divisions: (a) source of supply to furnace door; (b) furnace door to heat mains; and (c) heat mains out through the building and back to the boiler. Eight selected New Jersey cities, four with very high fuel costs and four with very low fuel costs, were compared with twenty-seven United States cities presumably representing best practice. The basic elements in the comparison were set up by the author from the literature in the fields of engineering and school administration. All criteria were validated by seven engineers. Although the twenty-seven cities rated higher than the eight New Jersey cities, they partly performed only eleven of the twenty-seven basic requirements. McCullough (84, 85, 86, 87, 88) presented some of the findings from his study in current educational periodicals. Tyler (138) described a critical study in a large commercial building which resulted in a 15 percent saving in heating costs. This saving was brought about by such methods as reducing the temperature in unoccupied space, setting up a night operating schedule, and recirculation of 100 percent of the air when outside temperatures were low.

Grabarkiewicz (50) stated that too much or too little heat created an unsatisfactory living or working environment. He reported a study which showed that an increase in temperature from 68 to 75 degrees caused a decrease of 15 percent in the physical work of men even though they were stimulated by a cash bonus. Falk (35) described a study which resulted in an immediate reduction in heating costs. The rate of heat loss per hour for various inside and outside temperatures was determined. From these data, heating curves and heat loss curves were developed. By allowing the temperature of the building when not in use to fall as low as was consistent to prevent freezing, greatest economy was secured. An operating schedule was developed which showed for varying degrees of outside temperature

when to turn the steam on or off. He concluded that if an operating schedule showed the necessity of starting heating at 4:00 A.M., or earlier, the building had insufficient radiation. Tolmie (137) reported that stokers installed in the Rockford schools had resulted in savings up to 31 percent in heating costs. The first installation was made in 1931, and at the time of his report, seventeen grade school buildings were equipped. He found that stokers paid for themselves in ten years by the resultant savings. Robertson (116) reported that after using hand-fired, stoker-fired, and gas furnaces, Guernsey, Wyoming, had found that gas was cheapest, costing $675 instead of $888 for coal. Sheldon (121) described the oil-burning central heating plant at Mount Holyoke College. One service man attends to 170 furnaces. The author predicted that the cost of the plant, $180,000, would be amortized out of savings in eight years.

Lighting

Several pieces of research in lighting have been conducted under the stimulus of the Illuminating Engineering Society. These will also be treated in the chapter devoted to schoolhouse lighting since they involve the installation of adequate equipment, both fixtures and wiring, in both new and old buildings. The new recommended standards for lighting, approved February 17, 1938, by the American Standards Association (55), have not been accepted by the National Council on Schoolhouse Construction (51, 136). Whatever the ultimate decision by school administrators, certain suggestions made in the report apply directly to the maintenance and operation of the school plant. The report recommended that windows and equipment be kept clean, and that the wall and ceiling surfaces be maintained in good condition. A definite system of regular inspection, both visual and with the aid of a light meter, was urged. Inspection, replacement of blackened lamps, and the cleaning of all luminaire surfaces, should be done at least four times a year. Only by such precautions can a schoolroom, even though provided originally with adequate lighting, be kept up to satisfactory working standards. It is of interest to note that the Illuminating Engineering Society (56) in a special report on New York schools advocated that cleaning of all lighting equipment should be done at intervals not exceeding six weeks.

Economy in Utility Use

Losses through excessive use of light, power, gas, water, and telephone were discussed by several writers. *The Model Custodian* (69) gave a checklist of 40 items as a basis for reducing electric bills. In another article (145) 19 items offered means of reducing water losses. Pykoski (107) noted many suggestions for reducing utility costs. He advocated wherever practicable that light, water, and power be cut off at night. The use of regular reports and graphs and the comparison of schools in the same

group have furnished an incentive to reduce consumption. C. Allen (4) presented the results of a study of water losses in a small high school. Water bills which formerly were $60 per month dropped to $10 per month. Louthan (81) suggested two devices for reducing light and water costs. Reagle (110) told how Montclair, New Jersey, had reduced telephone costs and improved service by running an extension from the switchboard in the central office to each one of the school buildings.

Fire Protection and Other Safety Measures

The removal of possible fire hazards benefits school management both in the saving of lives and property and in the reduction of insurance rates. Fleming (39) found that $7,000,000 worth of school buildings burn every year. Eighty-five out of one hundred cases are caused by improper maintenance. He urged the use of a Self-Inspection Blank for Schools which was reproduced with his article. This blank was prepared by the National Board of Fire Underwriters and had been approved and adopted by the National Association of Public School Business Officials. Frommelt (45) showed the effect of fire hazards on school insurance costs. He noted the penalties as well as the credits which affected the rate. One survey revealed that approximately one-third of the average rate was made up of penalties. Although proper attention to construction details was a major factor in securing low rates, a large number of penalties could be eliminated at little cost by removing the potential fire hazards. Reger and Brake (111) advocated securing the services of a capable insurance engineer not connected with insurance companies or rating bureaus. His remuneration should be made contingent on the savings he could produce.

Linn (72), after estimating that at least 150,000 accidents occur each year in and on public school property, concluded that accidents do not "just happen." He urged school authorities to gather reports on accidents, placing emphasis on the causes. Then, after study, remedial measures may be taken. *The Model Custodian* (33) listed thirty-four points to be observed in order to eliminate accidents. Wooldridge (154) found that the adoption of three rules would secure comprehensive school safety: (a) Make the building as automatically safe as possible; (b) take measures to insure that the personal equation hazard is kept at a minimum; and (c) take measures to insure that safety consciousness is kept constantly alive in the minds of pupils, teachers, janitorial staff, and the general public.

Extermination

Laferriere (61, 62, 63, 64) described the best methods to be used in ridding school buildings of rats, roaches, and crickets. He found that the best raticides were barium carbonate and red squill. He found that sodium fluoride was the fastest and most toxic poison for roaches. He pointed to experiments which showed that molasses was the best attractant and sodium

fluoride and sodium fluosilicate the most toxic substances to be used in exterminating crickets. Ridding lawns of ants (6) and of moles (102) was described in *The Model Custodian*. Termite treatment (1, 127) was discussed in *Nation's Schools*.

School Laundries

Three schools (25, 53, 89) reported savings in expense through the operation of their own laundries. Alameda, California, high school with an average daily attendance of two thousand reported annual savings of $700. Culver Military Academy reported laundry costs, including maintenance, insurance, depreciation, 4 percent interest on investment, as well as labor and supply costs, of $0.068 per pound against contract price of $0.125 per pound. Corresponding savings were made on dry cleaning. Pasadena, California, likewise reported reductions in laundry costs.

Painting and Decorating

Musick (96) described a test of the painting of schools in Kendall County, Illinois, made by Carl Heimbrodt of the Better Lighting Institute. He found that three-fourths of the schools were decorated with color that was entirely too dark. A large percent were decorated with medium buff which not only is depressing but has a low reflection value. He discussed the factors to be considered in color selection and gave the reflective values of various colors. Smith (123) noted the colors suitable for various types of rooms. He feels that every child has a right to happiness. If the proper selection of color on the walls of our schools will aid him in this pursuit, then it is a duty to provide it. Bennett and Maloney (10) noted that painting was closely tied up to the problem of illumination. They believed that yellow, brown, or red shades should not be used because of the harmful and fatiguing effect upon the eyes. *The Model Custodian* (140) described tests conducted by the research division of the New Jersey Zinc Company. Rooms were painted with various colors, but had equal wattages of electricity. Light meter readings revealed that with indirect light, white was 67 percent more efficient than yellow, 78 percent more efficient than green, and 89 percent more efficient than grey. The same relative values were found with semi-indirect, direct, and natural light.

An article in *School Management* (98) advocated the use of a coat of starch or buttermilk over the final coat of paint or glaze on the walls and ceiling. An article in *Nation's Schools* (104) suggested a thin film of water wax. In a third article (126) a thin coat of soap on glass, metal, or tile adjoining surfaces to be painted was advocated to reduce the amount of after-cleaning required.

Hookway (54) stated that exhaustive research had shown that egg-shell white was best for ceilings, nela light green for upper walls, and nela medium green for wainscot. Since labor constitutes the largest single item in painting cost, he advocated the use of paints which would give long

service and withstand repeated cleanings. Public School Business Officials (99) favored ready-mixed rather than lead and oil paint for interior work. Such paints have a uniform color, do not turn yellow with age, do not require a first-class painter to mix and apply, are cheaper, and are quick drying. The uses of paint thinners were discussed in two articles (133, 134).

Exterior Wall Maintenance

Weather is the enemy of buildings. Walls, chimneys, and other exposed portions of a building are subject to many conditions that require repair. An article in *Nation's Schools* (52) noted that at the building managers' meeting in New York City, those in attendance had agreed that the entire exterior of a building should be examined, preferably by using a scaffold, every five years. Such an examination should reduce the hazard from falling stones present in buildings having much of the so-called "gingerbread." Another article in *Nation's Schools* (150) gave a list of items to be checked as possible causes of leaking walls.

A consensus of writers on the subject indicated that there is no one cause of leaking walls and no single cure. Casterlin (18) secured satisfactory results through the application of a colorless, liquid water-proofing material which was applied with a calcimine brush. Frommelt (46) advocated furring as an excellent preventative if incorporated in the construction of the building. He made suggestions concerning various wall treatments and their limitations for each difficulty.

Nation's Schools (47) described the cause of efflorescence and advocated the use either of a stiff fiber or wire brush or a weak muriatic acid wash for its removal. To prevent its reappearance the use of the following materials was suggested: sodium silicate, magnesium fluosilicate (for concrete and stucco), and materials of dissolved paraffin type (for brick and stone).

Moore (95) contended that even among experts, opinions and recommendations for leaking walls are varied and controversial. His opinions were based upon a review of contemporary research coupled with his own careful observations. He believed that poor workmanship was not generally the cause. He advocated calking compounds where major movement occurs, plastic pointing where minor movement occurs, and tung-oil paraffin transparent water-proofing on all porous masonry. He, too, advocated furred walls. Finally he concluded that the building owner or manager must determine the sort of treatment needed and take his own gamble on the results, leaving the contractor to guarantee only proper workmanship. Macrie (90) discussed in detail the methods used in cleaning out the joints and repointing the walls of the high-school building in Hammonton, New Jersey. *Nation's Schools* (23) described repointing, damp-proofing, weather-stripping, and calking and the advantages to be secured from each of them.

Bailey (8) and Lamb (67) both gave excellent suggestions concerning roof maintenance. The former emphasized the importance of regular roof inspections once a month or even, in some cases, once a week. The latter

advocated the use of felt paper impregnated and laid with asphalt as best for long life.

Maintenance of Grounds

Nation's Schools (36, 68, 97, 132) printed four articles, and *The Model Custodian* (29, 66, 112) three, on the subject of lawn maintenance. All agreed that new lawns should be started in the fall and that no winter blanket was needed. Mitchell (92) explained how to construct a playground surface which would be properly graded, adequately drained, and surfaced with a suitable material. He proposed that the surface be composed of one inch in depth of limestone slag one-eighth to one-half inch in size, 50 percent passed through a one-fourth-inch mesh screen and free from dust. Occasional floating was the only maintenance required.

General Maintenance

Cunliff (27) advocated a long-term maintenance plan for school plants. Such a plan involves a scientific determination of the useful lives of the important elements in the structures, and the most economical means of keeping them in efficient operating condition. In another article (26) he showed the part played by accounting in bettering school maintenance. Walker, Emerson, and Bain (143) concluded that experience in building maintenance breeds conservatism and that the safest policy is to depend upon reputable contractors and factory maintenance men rather than upon high-pressure, cocksure salesmen.

In a study of the health of 5,150 teachers (30), it was found that defects in the school plant were an important cause of loss of time by teachers for illness. Among the defects listed were: (a) lack of comfortable rest rooms; (b) noise outside; (c) defective ventilation; (d) dusty classrooms; (e) lack of sanitary and convenient equipment for drinking water; (f) improper lighting; and (g) lack of sufficient and sanitary toilet facilities.

The Model Custodian (57) gave some excellent checklists to be used in the inspection of school buildings and grounds. School business officials (94) concluded that no major repair jobs should be done by regular school building employees. Many school districts maintain a small crew of skilled men of different trades who take care of emergency "major" work during the school year, and who, during the summer vacation period, act as foremen for larger crews made up frequently of men selected from the operating department. Another article (113) described a somewhat similar plan used in Atlantic City.

Duemke (31) advocated that building maintenance, alterations, repair, and remodeling should be done while the schools are in session. If such work is postponed until summer, competent labor is scarce. In Minneapolis, he said, only highly specialized workmen of exceptional moral standards and good mental and physical abilities are used. Womrath (151) stated that 2½ to 3 percent of the value of the school plant was required for

annual maintenance. He presented suggestions relative to various tried maintenance measures. An article in *Nation's Schools* (128) described some maintenance practices observed in Houston. Gleason (48) gave some valuable points on the summer renovation program. He advocated grouping projects by buildings and thoroughly renovating one or more each year.

Calhoun (15) described the use in Tennessee of county school mechanics in a number of areas. Started in October 1934 as a demonstration by the Julius Rosenwald Fund, the author concluded that these mechanics were not merely justifiable but highly desirable factors in the school maintenance and improvement program.

Miscellaneous

Scherer (118) reproduced a copy of the rules and regulations concerning swimming pools used in Rochester, New York. He also gave detailed instructions for swimming pool operation. *The Model Custodian* (131) and Price (103) presented detailed directions for the operation of swimming pool equipment. Luehring (82), in a doctoral dissertation soon to be published, devoted a section to "Standards for Engineers." He contended that the duties and responsibilities involved in the maintenance and operation of swimming pools are such as janitors are rarely able to satisfy. Only especially qualified persons should exercise the functions of janitor-engineer for a swimming pool. The author's standards should prove a valuable guide in schools maintaining pools.

Should blackboards be washed? *The Model Custodian* (13) reported that the National School Supply Association said "No," while Rupert of the Mellon Institute contended that no unconditional answer was possible. It was agreed that the janitorial staff and not the pupils should clean the boards. When blackboards require resurfacing, Pykoski (106) found that hand work with carborundum stones rather than the use of grinding machines and lathes was most practical.

Engelhardt and Engelhardt (34) presented standards for maintenance and operation of school plants as Section XII of their score-card for business administration.

CHAPTER II

Equipment, Apparatus, and Supplies[1]

R. W. HIBBERT

Equipment and Apparatus

Classroom Equipment, General

IN CONSIDERATION of the school classroom one should not lose sight of the fact that windows, floors, partitions, and plumbing may in certain respects be considered as much room equipment as pupils' desks and other usual equipment items. These subjects are treated elsewhere, but a few references are included here. Beatty (160) contended that learning is greatly facilitated in a well-planned room with well-designed furniture. He stated that movable furniture properly designed may be a great asset to the newer type of learning. The necessity of eliminating noise from the classroom was emphasized by both Friend (186) and W. C. Martin (231).

The importance of correct and adequate lighting as an essential phase of the classroom equipment was stressed by a number of writers who discussed the problems from an educational, rather than a technical, point of view (166, 209, 243, 248, 266, 267). Holmes (209) believed that good scholarship is dependent upon good lighting and advocated the use of the photoelectric cell for the automatic control of classroom lighting. Pierce (248) shared a similar view and indicated the necessity for proper utilization of light sources to maintain lighting standards under varying conditions of daylight. The article stated the advantages of installing an electrical eye in each classroom which would control the light at the desks farthest from the windows. Sturrock (267) recommended trial lighting installation of better lighting units as an initial step toward overcoming the present recognized deficiency in lighting. He pointed out the usefulness of special blackboard lighting equipment units.

Windows as an adjunct to proper lighting were discussed by Engelhardt and Uhl (177) and Harrison and Fouilhoux (198). The first article presented a technical treatise on window construction and the latter listed seven types of windows.

Honnold (211) stressed the importance of selecting durable and attractive materials for floors in school classrooms. He listed the different types of flooring best suited to different parts of the school building. Tooker (276) presented a description of what he considered the best types of floors for school buildings.

Harrison and Fouilhoux (199) reported that permanent partitions make it difficult to secure maximum utilization of room spaces, and also that

[1] Bibliography for this chapter will be found on page 471.

EDITORIAL NOTE: The purchasing and administration of supplies were treated briefly in the *Review of Educational Research* for April 1938 (Chapter IX, p. 168–70).

original planning should provide for the possibility of removing partitions between classrooms so that two classrooms may be united into one large space.

Classroom Seating

Trends in types of school seating were discussed by Hamon (195). He supported his discussion by including a table showing that the proportion of stationary pupil units in use declined steadily from 74 percent of the total in use in 1927 to 35 percent in 1933. Conversely, the proportion of movable pupil units increased from 26 percent in 1927 to 65 percent in 1933. Parmerter (245) considered the benefits of correct seating of pupils, and showed how correct posture in sitting reacts for good upon mental efficiency and physical energy. A description of a seating plan which permits the classroom to be transformed into an auditorium was described by Moody (241).

Nursery School and Kindergarten Equipment

The recent growth and expansion of nursery schools has occasioned consideration of equipment necessary for these schools. Stoddard (262) stressed the fact that too little attention has been given to nursery school plans and equipment. He concluded by listing eighteen essentials of the nursery school plant, and gave a list of available bulletins for those interested in current developments of nursery schools.

Kindergarten equipment was interestingly discussed by Brownell (161), Lyden (228), and Smith (260). Lyden gave specific rules for choosing outdoor equipment while Smith's article is accompanied by floor plans, as is that of Brownell.

The School Office and Library

The literature mildly criticizes school architects for lack of sufficient study of the school office. Ford and Winn (184) reported that almost three-fourths of the high schools throughout the United States are in need of better office provisions. Two office layouts of different Los Angeles high schools were presented as illustrations of adequate and economical plans. Design of office furniture and equipment was also discussed. Otey (243) pointed out that a model arrangement of the office can greatly improve school routine efficiency. He listed the necessary equipment, files, desks, vaults, etc., and gave plans for one-, two-, three-, and four-room office suites in schools.

The importance of adequate and functional equipment for the school library has been frequently discussed in recent literature (182, 183, 212). Fargo (182) discussed the size of shelves, spacing, distances and placing of windows, and the storage of items other than books, such as pamphlets, clippings, maps, and charts. The complete floor plans of a library suite in

the Pierre S. Du Pont High School, Wilmington, Delaware, accompany this article. Fenner (183) told of converting the high-school library from a regular schoolroom. Besides tables and other typical library furniture, it was decided to have sofas and wing and club chairs for an informal and attractive atmosphere. This library, because of its inviting and comfortable appearance, has become a gathering spot for the pupils of elementary age and is conducive to their spending more time in the library and getting the "library habit." Horrall (212) portrayed the necessity of having the library properly equipped, and explained the conversion of the elementary-school library from a dark and musty one-room affair to the presentday modern and cheerful room.

The School Auditorium and Stage

The growing demand for the wider use of schools, which has occasioned the more frequent use of school auditoriums, is responsible for an increased interest in the study of the school auditorium and stage. Hemenway (200) presented a highly informative article concerning all phases and aspects of school auditoriums. The importance of proper lighting equipment for the auditorium stage is generally recognized (157, 172, 181, 188). All elements that make it possible to control light efficiently and effectively with professional equipment are available to the amateur. Spotlights are playing an increasingly important part in theater lighting. The best known spotlights are of the lens type in which a lens collects the light and concentrates it into a beam. Fuchs (188) outlined the necessity of lighting equipment and presented information on the construction and painting of scenery.

The School Cafeteria

The school cafeteria has become one of the important features of most school buildings. Modern equipment is discussed in recent articles: Adams (157), Bryan (163), Curry (170), Essex (180), Graves (193), Hoskins (213, 214), Knoll (220), Llewellyn (223), Moran (242), Thomas (275), and Wall (279). Bryan (163) gave a detailed description of requirements and equipment for the school cafeteria, including location, size and shape of rooms, lighting, ventilation, sound-proofing and sound-deadening, furnishings, service counter, and kitchen equipment. Curry (170) listed a number of items to be studied when a cafeteria is established. She made the following points: (a) The initial expense may not be significant in comparison with the cost of upkeep; (b) equipment should be substantially built; frequent replacements involve additional outlay of money and require time for installation; (c) it is expedient to discard old pieces of equipment for new and improved types; in the selection of new types the manufacturer's guaranty is important; (d) it is not safe to estimate possible need for new pieces of equipment on the basis of average number of students buying their luncheon in the cafeteria; (e) the size of equipment

should be adequate for its purpose as it is a bad policy to overload ovens and refrigerators; and (f) a close comparison of equipment put out by several concerns is most beneficial.

Moran (242) showed how a small school overcame the inadequacy of children's cold lunches by equipping a lunch room at minimum cost to serve hot dishes for the youngsters, and gave a list of every piece of equipment used to serve thirty-five children. Essex (180) presented practical suggestions for designing and equipping the cafeteria of a small school for multiple use. The cafeteria can be used for purposes other than serving and eating, such as dramatics, play, physical training, and an auditorium. Graves (193) wrote a comprehensive article on modern equipment for school cafeterias. Hoskins (214) and Llewellyn (223) stressed the use of stainless steel equipment, while Hoskins (213) also concluded that the interior of a cafeteria is made more attractive by black porcelain counters topped with stainless steel. Thomas (275) emphasized the need for standard equipment, such as steam tables, ranges, dishwashers, and kitchen utensils. His thought is that ten- or twelve-foot tables of two-foot width are most economical, and that solid tables are best. Stools without backs are recommended. The entire equipment should be constructed for rough usage, and should be plain, substantial, compact, and serviceable.

The School Radio

The need for inquiry into the use of radio equipment used in schools was expressed by Lowdermilk (226). This article presented two striking trends: (a) rapidly growing preferences for centralized equipment, as opposed to individual radio receiving sets, and (b) steadily mounting interest in potential applications of equipment to pupil activity work and drama production. He suggested also that the advent of the audio-frequency amplifier has been hailed by schools as the ultimate solution to the problem of providing adequate program listening facilities, and stated that interest in radio-sound has not abated in the least in its decade of usage, but on the contrary, it has gained in general interest. Others expressed the view that equipment improvement has influenced the range of teaching through the application of a centralized radio-sound system. Greater versatility, resulting from rebuilding equipment, makes possible other applications, in addition to the one in mind originally. New teaching applications follow the equipment manufacturers' improvements in their products: Currington (169), Devereaux (174), Lowdermilk (226), Perry (246), Randall (254), Rowley (258), and Tyler (277). Tyler called attention to classrooms that are being acoustically treated, enabling programs to be presented without distortion and heard without strain. In buildings not acoustically treated, some improvement is made by adjusting tone control. He also indicated that central sound equipment is becoming more common, both in new school buildings and in old ones. The central program distributing unit with loud speakers for each classroom is becoming almost universal practice. Perry (246) showed that radio is an established and permanent addi-

tion to school equipment. He outlined future improvements and stated that television is only waiting for the adjustment of economic conditions. Randall (254) emphasized that a radio system is within the reach of any school.

Pictures and Sound

The American Council on Education, with the financial support of the Payne Fund and the General Education Board (192), has carried on a number of activities in this area during the past several years. One of the undertakings was a survey of the audio-visual equipment owned by the elementary and secondary schools of the country. The Council has also cooperated in the collection of film catalogs, exploratory studies of various subjects to determine the needed films, the methods of distributing motion pictures, and their actual use in schools and on adult programs.

Much interest in the subject of radio in education is expressed by many writers. Among them are Bauer (159), Brunstetter (162), Devereaux (174, 175), Marshall (229), Roberts (257), A. J. Stoddard (261), and Worrell (282). Brunstetter (162) reported the essentials in equipping a room for educational sound films. Devereaux (174) presented a detailed account of equipment necessary for audio-visual usage. Ramseyer (253) said there should be a director appointed to have charge of visual aids. His duties would fall into three classes: (a) to see that necessary equipment and supplies are provided and kept in good condition, (b) to set up a smooth working organization so aids may be constantly available with as little friction as possible, and (c) to see that members of the staff use aids effectively and that these are properly correlated with other educational activities. Sullivan (270) outlined mechanical requirements to be met in installation of visual-aid equipment, and gave rules to follow in operating the sound machine. Crippen (168) felt that the abundance of free film subjects of extensive specialized productions now being offered at nominal costs makes the school visual program attractive.

Stracke (264) outlined a program of social interpretation through the medium of published photographs and motion pictures. Hutchinson (215) discussed the great possibilities in the field of visual education, and listed different pieces of equipment for visual aid in schools. Studebaker (266) wrote on mechanical and non-mechanical audio-visual aids to instruction. Devereaux (175) discussed the necessity for talking pictures in the schools, and gave a detailed outline of physical requirements for classroom projection. Roberts (257) stressed the importance of proper purchasing of sound equipment. A. J. Stoddard (261) showed that talking pictures are an outgrowth of the desire to devise more effective means and methods of acquiring and transmitting knowledge and skills. Worrell (282) wrote an article on the comparative advantages possessed by the sound projector and silent projector in the hands of a capable teacher. Hansen (196) discussed this subject administratively, suggesting the use of a chart so that all the teachers may be informed of the materials that will be available.

Physical Science Equipment

The key-note for physical science equipment is simplification. The Division of Chemical Education, American Chemical Society, appointed a Committee on Minimum Equipment whose report (255) included a list of experiments and apparatus designed for small classes (ten to twelve students). The minimum equipment is classified under three headings: (a) individual apparatus, (b) desk apparatus, and (c) common equipment. This article also presented an extensive list of additional desirable apparatus. The question of what enrolment the equipment is to accommodate deserves attention (224).

The setup of the physics laboratory was given special consideration by Moehlman (240), Stogsdill (263), and Korff (221). Particular problems of the college laboratory were discussed by Foulk (185).

Household Arts Equipment

The general trend in home economics laboratories seems to be toward the home-making type of equipment; that is, a complete set for a suite or apartment, similar to the average home situation. In some cases the laboratory itself is so equipped that various phases of home-making activities may be carried on (194, 210, 271, 278). Swain (271) gave detailed outlines of room layouts and equipment necessary to satisfactory working of this plan. A bulletin of the United States Office of Education (278) devoted a special section to stoves. Three general considerations influencing the selection of stoves were emphasized: (a) They should be simple of style and suitable for a home kitchen; (b) they should utilize the fuels most commonly used in the community; (c) they should illustrate, if possible, the style of stove and type of fuel which will be used in the future in the community. This publication also details combinations of furniture which have proved to be satisfactory equipment for a working center of four pupils. Greene (194) explained the use of screens to form unit kitchens.

Industrial Arts Equipment

Trends in industrial arts education have been toward the general shop. Davis (171) indicated the trends in methods, organization, and selection of subjectmatter for the general shop. This article described the different types: (a) general shop, (b) general wood shop, (c) general metal shop, (d) composite or comprehensive shop, and (e) unit shop. If only one shop is possible, such as in a small school, it should be a comprehensive general shop, which would include woodworking, cold metal works, drafting, and electricity. Schools with more than one shop, but not sufficiently large to call for a battery of shops, should have a general woodworking, general metals, and graphic arts shop—the latter including drawing and mechanical drawing.

A recently published monograph (219) presented a detailed checklist of tools and equipment. The Michigan Industrial Education Society (236)

recommended general mechanical drawing for all schools, and outlined in detail the equipment and supplies necessary for teaching it. Jennings (218) discussed the rapidly growing processes of gas and arc welding, listed equipment and supplies necessary for such courses, and gave practical suggestions and help in the matter of shop organization. Emerson (176) presented a detailed listing of equipment for a printing shop, including the size of the printing press, types of cabinets, steel storage, and shelving. Persell (247) wrote an unusually interesting article on equipment. G. H. Martin (230) gave a detailed account of equipment used in vocational school shops. He also gave detailed lists of equipment needed for carpentry, plumbing, and electrical shops, as well as the mill room. Fryklund (187) gave reasons for increased interest in industrial arts education. He also stressed proper equipment for work of quality, and insisted that industrial arts in education must learn to overcome waste in shops.

Physical Education

Recent literature in the field of physical education equipment deals primarily with purchasing, distributing, reconditioning, and storing athletic equipment. Alperin (158) stressed the purchase of substantial equipment as compared with cheap goods at a lower price. Hoehle (208) outlined a procedure for the repair and upkeep of balls used in athletic games. McKee and Gray (233) gave detailed suggestions for the choice and use of playground equipment. Cook and C. F. Martin (165) discussed play areas, presenting views on arrangement of apparatus and equipment, layout of grounds, and landscaping the playgrounds. They presented excellent charts, one a typical elementary-plot plan, another a typical layout for junior high school. A thoroughly organized plan for management of "The Athletic Equipment Room" was presented by Pulver (251). This discussion also included diagrams of typical forms which can be used advantageously in checking athletic equipment. Weaver (280) presented a detailed article on equipment and plans of playground areas for elementary schools. He gave a list of standards necessary for games and activities.

Music

Little is found concerning musical equipment in recent literature. Hanson (197) believed in lifting music from a professional setting and placing it in direct contact with the students. Gibson (191) discussed band instruments.

Commercial Subjects

There are few articles on equipment for teaching commercial subjects. Loso and Tonne (225) suggested equipment for business training of students in secondary schools. Burmahln (164) showed how modern equipment in the typewriting rooms furnishes pupils with incentive for good

work. McNamara (235) presented the need for office training in the schools. The most important equipment for this training is the various machines used in everyday office practice, such as adding, mimeograph, dictaphone, etc. The article listed twenty-one pieces of equipment necessary to carry on this project.

Maps

The importance of the inclusion of maps as a necessary equipment item is brought out in recent literature (238, 250, 256). Rigdon and Sorenson (256) gave a detailed description of equipment involved in the study of geography. Price (250), in discussing the use of maps for reference work, listed four types—pictorial, sand table, relief, and wooden. Miller (238) stated that the benefits of a map survey are to show whether the schoolroom is adequately supplied with visual aids, to discover whether material on hand is suited to needs which it supplies, and to discover damaged and outworn visual-aid material.

School Supplies

A recent research bulletin (248) suggested that supplies may be defined as those commodities which are consumed during the course of a school year. For the more exacting requirements of school accounting, supplies may be defined as: (a) materials consumed or destroyed when used; (b) materials, the normal life of which when in use is not more than two years; and (c) fragile articles frequently broken with customary usage and small articles frequently lost under similar circumstances.

Practices vary with respect to the kinds and amounts of instructional materials the school district furnishes, as well as with respect to the classes of pupils provided with such materials at the expense of the school system (201). The tendency for the local schoolboard to pay for pupils' supplies with monies appropriated in the annual school budget seems to be increasing. Answers to questionnaires sent out indicated that 56 percent of the cities below 30,000 population and 67 percent of the cities above 30,000 furnish all supplies to pupils free (216).

Supply Standards and Specifications; Purchasing

A recent study, sponsored by the National Association of Public School Business Officials and published in bulletin form, devoted a section to standards for selection of supplies (248). The following aspects were listed for consideration: (a) purpose for which an article is to be used, (b) quality of supplies, (c) cost of supplies. The publication drew the following conclusions:

1. Standardization of instructional supplies involves the study of utilization, selection, purchase, and distribution of materials. Standardization should not limit utility. A continuous analysis of instructional materials as to type, quality, service, and use is necessary.

2. Efficiency in requisitioning, budgeting, purchasing, and distributing educational supplies demands that utilization standards be developed. Standards of utilization or consumption are those developed in connection with the use of supplies in instructional activities, such as quantity, time when used, place where used, and by whom. Standard instructions controlling use of special supplies are important.

3. Standards for school supplies and equipment should be established through cooperative study and efforts of the most capable people in the system. Teachers, supervisors, and department heads should be consulted regarding minimum requirements for their departments. True economy requires the adoption of standard supplies and equipment that meet all the minimum requirements of the users, but no less.

4. In establishing standards, current literature on the selection of supplies, curriculum needs, quality, cost, quantity, and utility should be considered.

In seeking bids for school supplies, a great number of school systems prepare lists of their needs for the following term. These lists indicate the amount of supplies needed but usually give little information as to quality. In other words, definite specifications to guide the supply houses are usually lacking (248). Establishing comprehensive specifications for school equipment and supplies demands close cooperation between the educational and business departments of the school. The central supply department or purchasing agent cannot alone determine satisfactory specifications. The teacher and the administrative staff must work together in translating knowledge of supplies and equipment into desired specifications. The preparation of such specifications involves a number of steps (272, 273): first, the experimentation and testing necessary to determine which is the most satisfactory type and quality of article for the particular instructional job; second, the writing of specifications so there will be "no loop holes"; third, the development of specifications which will not handicap some high-grade standardized product; fourth, the setting up of standards which will not require a special manufacturing process and thus add to the cost of the article.

Ernst (179) told how items must be judged and showed the necessity for giving definite reasons for each purchase. It is mentioned that the best values offered may not be the ones at the lowest price. Hibbert (206) indicated that the goal of every teacher, supervisor, or administrator is the improvement of instruction. Business officials are interested in this problem as it relates to the selection of proper supplies necessary to maintain and improve instructional procedures. Strickler (265) reiterated that the efficiency of the classroom teacher, regardless of his preparation, can be raised or lowered by the adequacy or inadequacy of the materials furnished him. He also pointed out that standard lists of supplies are desirable, especially in districts having more than one building. Teachers are not always satisfied with standardization, and this is the reason why they should have a part in making the standardized list. Gaiser (190), in a comprehensive treat-

ment on procuring equipment and supplies for educational institutions, showed that selection, purchase, and delivery of equipment are closely allied to the educational program. He stressed benefits of standard lists, and also gave detailed information on actual purchasing of equipment and the drawing of specifications.

McAllister (232) indicated there are many types of standards sponsored by the federal government which might be utilized by the schools, but only those relating to commodities purchased for school purposes are touched on in his article. James (217) gave a summary of the high-lights in the preparation of supply lists. He stressed alphabetizing items, or grouping in sections, and stated that the next step is the outlining of specifications sufficiently clearly to identify and establish the quality of item desired.

A careful examination showed that less than one-half of the states have any definite statutory provisions for bids or proposals for purchase of supplies. There are, however, twenty-two states which have laws requiring boards to place the purchase of supplies and equipment on a competitive basis (259). Hibbert (204) recommended a standard list of authorized supplies. James (217) outlined six essential steps to be followed in purchasing supplies. Another author (252) contended that the job of purchasing supplies would be greatly simplified by requiring each educational staff to submit to the business offices lists of articles used in schools. Sykes (274) wrote that a detailed analysis of methods used by schools in purchasing supplies and equipment revealed that the larger school systems used specifications more frequently than the smaller school systems, and that a program of testing and checking quality is a definite part of the purchasing procedure. Councell (167) emphasized the need for periodic ordering and periodic delivery as one of the correct procedures of supply purchasing. Hibbert (205) emphasized that supplies purchased must be checked against the purchase order and compared with samples or tested to see that they meet specifications. Lewis (222) contended that large savings are effected by purchasing the minimum quality that meets actual needs.

Storage of Supplies

The administration of supplies is discussed by Suffield (269) who presented a comparison of different cities. James (217) pointed out that distribution is the phase of handling supplies which is most difficult to systematize and is likely to be slighted. Decker (173) discussed the question, "Shall purchases be made for direct delivery, or shall there be a central warehouse?" This is an ever present question in connection with small city systems, and is more fully discussed in Bulletin No. 6 of the National Association of Public School Business Officials (201). The use of a central storage depot for school supplies is practiced by 76 percent of the schools studied in the bulletin. Many writers expressed beliefs that such a storage procedure is fundamental (167, 201, 203, 217, 234, 237). Miller (237) listed as reasons in favor of the central warehouse: (a) more efficient control, (b) less money invested, (c) lower insurance costs, (d) less waste,

(e) greater safety of materials, (f) fewer losses because of rodents, leaks, etc., (g) better and safer storage of explosive and inflammable materials, (h) more equitable use of supplies, and (i) less total space for storage. McLain and Condit (233) pointed out that small cities can deliver from central storage to advantage.

Councell (167) gave a detailed account of equipment necessary for the supply warehouse and traced the routine of supplies from requisitioning by teachers of various departments on through bids by vendors for the order, ending with disbursement of supplies. James (217) suggested the following rules in the matter of storage:

1. Assign different sections of the storeroom to various types of supplies, such as "art supply section" or "janitor supply section."
2. Unpack and shelve a working supply of all items of small bulk or high value.
3. Check all merchandise received, using duplicate copy of purchase order or invoice and noting shortage, damaged items, and back-ordered items.
4. All packages, cartons, etc., when stored, should be faced toward aisles, so that labels and content markings are easily seen.

Delivery of Supplies

The use of a central storage plan necessitates some type of delivery system for transportation of supplies from storage to different school buildings. Some factors influencing the method of delivery adopted are the frequency of deliveries, distances between the several school buildings, and the types and amounts of supplies furnished to pupils. Several common methods of delivery reported by the school systems are delivery by self-owned truck, delivery by commercial cartage companies, use of cars owned by employees, and such haphazard methods as personal delivery by student employees (201). Approximately 60 percent of the school systems using the central storage plan of handling supplies have a school-owned truck for making deliveries from the central storeroom. Supplementary delivery is frequently provided, different agencies being employed by different school systems. Many factors influence the frequency of delivery of supplies from the central storeroom to various buildings or classrooms. The most important of these are size of storage space in individual school buildings, the size of cupboard or closet space in the separate classrooms, and the method and type of transportation facilities for delivering supplies from central storage plant to individual buildings. The cost of delivery service is affected by the method of delivery, as well as by the frequency of deliveries and the extent to which different kinds of supplies are handled through the central storage unit (201).

Supply Control, Requisitioning, Accounting

The use of a regular form for requisitioning supplies was found to be almost universal among the systems having a central store. The alternative is the issuance of materials on verbal request with no written records of the transaction being kept. The most common procedure is that in which

the principal of each building sends in a list of supplies needed (201). Schools are usually limited in the amount of supplies to be requisitioned on either a material quantity basis or a money allowance basis. Hibbert (205) indicated that the amount of each supply to be allowed per school, per pupil, or per teacher may be determined by: (a) a quota recommended by supervisors, these recommendations to be based on school needs as determined through their experiences; or (b) a quota based on previous school usage.

Moe (239) described cost studies in seventy-two schools. Abbett (156) dealt with the recording and accounting of supplies. The simplest form of stock record, he stated, shows the dates and quantities received, and posts the results of periodic physical inventories. He pointed out that in a complete system, a control should be set up in order to maintain efficiency in the replenishing of stock, to assure proper distribution of issue charges, and to establish responsibility and accountability of those handling stock.

Henzlik (202) stressed the significance of taking the school inventory and carefully accounting for supplies, listing ten values of the inventory. Hibbert (205) quoted a previous study in support of the contentions that: (a) Inventories of school equipment are taken by three-fourths of large city school systems; (b) most of these are periodic inventories taken annually; (c) the best time for this process is near the end of the school year; (d) the school building is the common inventory unit; (e) regular educational employees take the inventory, the principal being responsible for the work; (f) the equipment inventory is necessary for each department of each school; and (g) a complete inventory should contain equipment items with some identifying specifications, quantity, unit price, total price or value per item, and total value of equipment assigned to each department.

General

Gaiser (189) outlined the organization of purchase, delivery, and maintenance departments, and discussed the requisitioning of supplies. Weller (281) reviewed the findings of school surveys dealing with problems of school business management in various school systems, stressing control of the supply depot and regular delivery schedules. He also suggested an annual audit of transactions of the supply depot. Engelhardt and Engelhardt (178) gave standards and a score-card for the administration of supplies and equipment.

CHAPTER III

Heating, Ventilation, and Sanitation in School Buildings[1]

H. W. SCHMIDT

SINCE PRESENTING THE SECTION on heating, ventilation, and sanitation in the October 1935 issue of the *Review of Educational Research*, the writer has attempted to keep informed of further research and studies in these subjects. The "spring tide" of investigations and research of the earlier years has been superseded by a correspondingly low ebb. Attention has been paid to the development of air conditioning, but so far little attempt has been made to apply this to schoolhouse operation. Virtually all experiments and investigations so far have been in connection with commercial, industrial, and private home installations. One may, however, look forward to school jobs in the near future.

A check of the existing literature on the subjects of heating and ventilation shows a dearth of research material as compared with that available previous to 1935. Nearly all articles found concern themselves with minor matters and refinements of operation and one looks in vain for authentic investigations and information on a number of still disputed points such as definite and specific requirements of outside air supply to classrooms, the amount of recirculated air required as a health factor, the effect of consistently low humidity, the cumulative effect upon the human organism of continuous adaptations to varying temperature and humidity conditions within the schoolroom itself, and dozens of other pertinent matters.

Summaries

A brief summary of the past and present heating and ventilation situation was given by Holy (297). He called attention, incidentally, to a number of needs and the necessity "for a long-time, well-integrated program of research in the field in an effort to obtain satisfactory answers to many problems now existing."

Noffsinger (315) also presented an excellent résumé of the progress of heating and ventilation in our schools during the past hundred years. He called attention to the various theories expounded in the past and the expansion of the subject which "has developed a new crop of devices, some accepted by one group, others adopted by another, all more or less experimental and creating seemingly endless controversy and confusion, the requisites of progress."

Air Quotas

Acheson (283) gave a brief statement on the use and application of various types of ventilating units and schemes and also went into the relative

[1] Bibliography for this chapter begins on page 476.

merits of the various schemes. The author made some comments on outside air supply and recirculation somewhat at variance with generally accepted notions and studies such as those by Houghten and others (301), Lehmberg and others (305), and others. The article (283) also called attention to the fact that "some states permit a certain percent of air to be recirculated even during school periods, but the state of New York does not permit such recirculation."

In respect to the admission of outside air, Acheson remarked: "It is generally accepted that under no condition should the amount of fresh air [outside air is not necessarily fresh] be less than 10 cubic feet of air per minute per occupant. Our observation is that this quantity is entirely inadequate for school ventilation, and we believe it is generally accepted that at least 20 cubic feet of fresh air should be admitted per pupil. The writer prefers 25 cubic feet during school operation. Our experience is that odors become disagreeable if less than 20 cubic feet of fresh air is admitted to the schoolroom per pupil per minute. There is plenty of oxygen with 10 cubic feet, but the extra amount of air is needed to dilute the odoriferous air and to give proper distribution."

The studies using respiratory diseases as criteria of effective ventilation are still in status quo and there seems no likelihood that they will be continued. With the situation more or less stabilized on a fairly well-established basis of a 30 c. f. m. per person air supply and a varying amount of outside air, rarely less than 10 c. f. m. per person (290), it seems that we have arrived at a lull in the storm of past discussions covering air volumes, open window ventilation, ozonation, and the relative merits of various systems.

Ventilating Codes

So far as statutory (code) provisions for heating and ventilation are concerned, some progress has been made. The Chicago code has been modernized but contains no startling provisions, except that the air conditioning code (289) has a good many implications in the direction of future applications to schoolhouse ventilation; the Ohio code has not yet been adopted by the legislature. It has been brought up to date and among other things provides for 50 percent of recirculated air if filtered or air-washed. It also permits window ventilation for one-story buildings of not more than eight classrooms. Other state codes have not been changed materially except the Wisconsin code (326) which was revised in 1935, and, on the basis of research studies, increased permissible recirculation to 66-2/3 percent and under certain conditions to 75 percent during occupancy. All mechanical systems require some form of automatic control. The old "square foot" basis has been replaced by an "occupancy" basis, allowing 18 square feet of floor space per person for classrooms and varying areas for other spaces. These provisions have resulted in economy of operation and apparently have proved satisfactory in field experience. Window ventilation is still not permitted.

Building Design

A study of the effect of air conditioning on building design was made by Canney (288). Some of the mechanical features discussed are applicable to schools. The author, however, does not make specific applications here.

The application of air conditioning to school buildings has probably lagged due to the fact that school buildings are not used frequently during the hot weather season. With the trend to use our schoolhouses more and more it may well come to pass that summer cooling, a factor of air conditioning, will be made possible. However, blower units, frequently but erroneously called air conditioning units, are being used more and more in the smaller schools, especially in rural areas. An article in a technical journal (286) called attention to the matter of utilizing an existing central fan system with automatic year-around control, thus adapting the system, with slight modifications, for summer cooling. That this matter is becoming one which is leading to study and detailed analysis may be judged from an article by Sturrock (321) on the effects of artificial lighting on air conditioning. His conclusions were that for summer cooling and ventilating, "where high levels of illumination are used which require 10, 15, or more watts per square foot of electrical capacity, careful consideration should be given to a separate ventilation system."

Odors as a Criterion

Apparently the relation of odors to ventilation, or rather air supply, is assuming considerable importance to judge by the amount of experimentation going on. Yaglou and Witheridge (328) conducted some experiments whose results were recorded in their final paper in July 1937. They found that odors were dissipated much sooner and more completely when larger air volumes were involved. The argument therefore runs that large cubic air space per person is conducive to better ventilation. However, no actual quantitative parallel was drawn between an ordinary classroom and one either very much larger or smaller. One might expect a dilution effect with large air volumes (air spaces).

Another laboratory study on minimum ventilation requirements was made by Lehmberg, Brandt, and Morse (305); they used a "box" to hold the human subject and also used odors as a criterion. They used the "noses of trained observers." Using varying quantities of outside air they found that with 5 c.f.m. of air from the outside the odor was objectionable, but that it was reasonably satisfactory when 13 to 27 c.f.m. were used. But even with 50 c.f.m., complete disappearance of odors could not be obtained. It is argued that the intensity of odor may be an indicator of minimum ventilation requirements. Though not expressed in this reference, frequent discussions among those of experience lead to the question whether body odors should be used as criteria. It is admitted that "the olfactory organs are quickly and easily fatigued if the exciting stimulus continues, although they can perceive the sudden appearance of new odors. The occupants of a

crowded and poorly ventilated room are not capable of recognizing body odors which are very apparent or even intolerable to a newcomer. Breathing fresh air restores the sensitivity" (285).

The effect of air movement and outside air supply upon schoolroom odors was studied by Houghten and others (301), and a similar study was undertaken by Yaglou, Riley, and Coggins (327). A concise abstract of these studies appeared in the *Architectural Record* (285). The study showed the effect of various amounts of outside air upon odors as determined by an "odor index" which, in turn, of course, is subjective. It was found that the outside air requirement was a function of odors and that "moderate" odors, the criterion, required 16 c.f.m. per person of outside air, but even with 30 c.f.m. per person the odor was still detectable. Interestingly enough, recirculation does not seem to affect the odor strength appreciably. "In other words, from the standpoint of body odor a room can be ventilated just as well with an air supply of 16 c.f.m. per person as with a total supply of 30 c.f.m., about half of which is recirculated" (285). It was also shown that air washing reduced the intensity of odors and if the recirculated air was passed through a spray dehumidifier the outside air could be reduced to 4 c.f.m. per person. It was also evident that the matter of odors was a socio-economic factor and often a definite local problem. Overheating appeared to be more of a ventilation problem than odors; this has been stressed in a number of previous studies (302, 312). Yaglou's study differed from Houghten's in that he used a small room, 155 square feet area and from three to fourteen subjects, while the latter used regular classroom areas.

Heating and Ventilating Economies

The economics of heating and ventilation has of late injected itself into the picture and this may well be so when hundreds of millions of dollars are involved in the operation accounts of our nation's schools. No doubt investigations along this line are in order as well as refinements in devices, controls, and operations. Forthcoming literature already foreshadows this. Anderson (284) and Frommelt (293, 294) gave rules for stoker selection and showed how operating costs may be reduced and better temperature regulation maintained. McCullough (308) made a plea for purchasing fuel on the basis of analysis and heat value rather than just contracting for coal. Proper specification and purchases on this basis will result in considerable economy.

Falk (291) called attention to reducing heating costs by judicious thermostatic setting, particularly for overnight heating. He showed that the cost of prolonged warming-up periods in the morning, due to low night temperatures, is expensive and a comparatively small temperature differential between day and night building temperatures is really an economy measure. The differential is a function of outside temperatures and therefore, of course, not constant. Beall (287) also gave some pertinent facts on efficient school heating. Norman (313) gave some interesting data on sea-

sonal costs of heating and ventilating a number of Iowa schools. The comparison features showed characteristic deviations due to the plants and building construction. Reynolds (317) gave some pointers on the care and maintenance of heating and ventilating systems; this, however, refers to a steam plant only. Scanlan and Jordan (320) showed how a school having a hot-air furnace was modernized with comparative ease by installing a unit ventilating system.

A rather careful study and analysis of fuel consumption and possible economies was made by McCullough (307) who studied in detail the "fuel program of eight New Jersey cities," and from this set up a "complete fuel management program for any school system." As "the annual purchase of fuel entails the largest expenditure for a single supply made by the school systems of the nation" McCullough felt that present practices entail a waste of fuel running into several million dollars annually and that a definite fuel program is essential. The program is very detailed and may be adopted in the larger communities but is probably too cumbersome for smaller cities. For those who care to go into still further details the publication offers an exhaustive bibliography on the subject of fuel and its allied uses.

The use of gas for heating purposes is prevalent in some sections of the country but is evidently not sufficiently safeguarded in all respects, for example, the New London, Texas, disaster in March 1937. Horn (311: 93-99) discussed this matter in some detail and made some suggestions of interest to those charged with operating similar plants. Robertson (318) also gave some technical information on the use of gas for boiler firing, including safety measures.

Other Factors

An article in one of the technical magazines (324) stressed the effect of sun and wind upon a building and their importance even when structures are properly insulated. However, no data were given on how practically to compensate for the effect. On the other hand, Mills and Olge (310) made a study of body heat and the influence of clothing and other factors as a part of heat comfort. They showed the importance of foil wall insulation as a feature in this connection. Another article (303) called attention to the infiltration through doors and the necessity of reducing this by the use of buffers, such as properly constructed vestibules. Considerable quantitative data were given.

Houghten and others (300) made a study of drafts in classrooms and the influence of the temperature in relation thereto. Unit ventilators were installed and used in the study. Apparently temperatures but slightly below the prevailing room temperatures are apt to produce drafts. For instance, an air movement of only 25 f.p.m. with the temperature of one to one and one-half degrees below room temperature produced a noticeable draft but not objectionable. But with a velocity of 40 f.p.m., a two degree lowered temperature produced objectionable drafts. The implication is, of course,

that higher velocities at higher temperatures may produce some drafts but these would not be objectionable.

The same authors (299) made a study of twenty rooms equipped with unit ventilators to determine the effect of closing off the room vents completely. Such closure reduced the effective discharge of the units from 1.7 to 25.9 percent, depending, however, upon the room characteristics and not outside conditions. There was a greater temperature gradient from floor to ceiling but, on the other hand, it was found that at the heating level the distribution showed little variation. The experiment seemed to prove that with a high velocity discharge the air distribution did not depend upon an active vent. No experiments with a plenum system were undertaken. Hattis (295) made a study of air ducts and their functions in a windowless building. The data presented were complex and somewhat at variance with those ordinarily used as a basis for calculations in a windowed structure. Due to the novelty of such windowless buildings, which may come for schoolhouses, much more experimentation will be required before reliable data in this direction are available. The investigation, however, is interesting and pertinent due to the absence of window infiltration, a rather important factor which must be reckoned with in ordinary buildings.

Ozone and Ionization

In previous literature on the subject of heating and ventilation, some mention has been made of the effect of ozone upon ionization. Little attention has been given to this plan of ventilation, although Feldman (292) gave us the result of some experimentation. An unpublished article by E. Robb claimed a superiority for unit ventilation and similar systems over furnaces, "due to the destruction of ionization because of the high temperature existing in the furnace airways, thus definitely diminishing the ventilation effect." Loeb (306) also made a study of the ions in air and their possible physiological effect. He came to the conclusion that the effect is essentially not good and that we have overestimated the influence of ionization in ventilation. Another study on ionization by Wait and Torreson (322) showed that the ion content of air within a building is largely due to contamination as a result of tobacco smoke, etc., which content disappears later and permanent ionization is due to external effects. This investigation, however, drew no conclusions as to the effect of ionization upon the human organism.

Psychrometric charts for determining air conditions in buildings have been of wide use and there has been a tendency of late in the direction of making more careful and detailed use of the charts. Hill (296) developed a refinement of psychromatics by using a new interpretation and chart. With more exact engineering practice this new chart will prove useful.

Sanitation

Sanitation and its related aspects, such as toilet rooms, equipment, drinking fountains, and other features have reached a comparatively quiescent

stage except for some technical details not of interest to the educator. So-called "back syphonage" or the tendency for waste water to back-flow into the main water supply is of some importance. It was found that certain valves and piping arrangements permitted this to take place at times. Most boards of health have taken cognizance of this feature and have issued orders and regulations whose object is to prevent this contamination. Large batteries of toilet fixtures such as those existing in schools have at times been offenders in this direction.

The question of the ratio of various types of fixtures to enrolment is apparently not yet a settled matter. It appears from the reviewer's experience that this matter is tied up with school organization and administration.

As a matter of record and as a basis for objective consideration, the Standards Committee of the National Council on Schoolhouse Construction (311: 131-33) set down some suggestions which appeared to meet the general situation reasonably. An unpublished investigation by the reviewer seemed to show that a slightly different ratio from the above, as set forth in the Wisconsin Building Code (325:141), is acceptable and has given no dissatisfaction to the educator, administrator, or architect. The general requirements for toilet rooms in this code may also be of interest (325:48-54, 141-42).

Maguire (309) made some interesting comments on the toilet room situation in New York City which threw some side-lights on the problems confronting the administration in large cities. An enlarged access chamber or "plumbing alley" as a definite means of improved service and repair was advocated. In a similar vein, Radder (316) called attention to the modernization of toilet rooms in some of the Chicago schools.

Foreign Literature

Except for a mass of detailed and highly technical material, the foreign literature available exhibits a dearth of usable material along the lines of this chapter. The modern construction features of schoolhouses, particularly in France, Germany, and England, received much space. A review of the London Exhibition by the Royal Institute of British Architects disclosed little of interest to the American educator. However, mention was made of some remodeling, showing "new classrooms have been added with cross ventilation" (natural) (319). The modern method of heating and ventilation, as practiced in this country, has not received any mention.

Conclusion

The comments made in an earlier review (298) as to recommendations are still valid and of force, except as Loeb's study (306) threw additional light on the influence of ozone in ventilation. Some progress has been made and some research problems are being set up now. Likely the future will give us a number of much needed answers to a large group of vital questions, although it will be admitted that we may not find a single answer to a number of them, owing to the variables involved.

CHAPTER IV

School Illumination[1]

W. W. CARPENTER and N. E. VILES

Early Studies and Standards

IN AN ERA when books were rare and not much intensive reading was required, little was known of the science of seeing or the quality of light needed for safety and comfort. Noffsinger (379) reported that glass windows in school buildings were a rarity as late as 1820. He cited authority to show that the first school unilateral lighting was in Boston in 1847; that high window heads were found desirable in 1868; that New Jersey first recommended windows with square heads in 1874; that a window area equal to 10 percent of the floor area was recommended in 1877; that this recommendation was changed to 25 percent in 1879; and that this ratio was reduced to about 20 percent in the 1889 recommendations. Ives (362) found that, by 1928, about one-third of the cities and states reporting were giving attention to wall and ceiling colors; about two-thirds of them specified unilateral lighting with a specified window area ratio; and that nearly one-half of them had specific recommendations for window blinds and the location of the windows. At this date only a few of the states or cities reporting seemed to have had any recommended standards for artificial illumination.

The Importance of Adequate School Lighting

The importance of proper illumination to health is indicated in recent literature. Hardy (360, 1934: 364-84), in a comprehensive treatise, outlined the physical, pathological, and physiological effects of light or visible radiation upon the eye. Henderson and Rowell (356) in a study of eye defects stated that "twenty-three out of every hundred persons under twenty years have defective vision." A series of studies reported by the National Safety Council (375) indicated that for postal clerks with defective vision it is desirable to have an illumination equal to fourteen foot-candles. One British study included in this report indicated that typesetters did best work when the illumination was increased to about twenty-four foot-candles.

Illumination, vision, and ocular fatigue are important factors in the health of the child and likewise in his school progress. Gradle (348) reported that in a Chicago survey one out of every seven children had a visual handicap to overcome. He stated that "the quality of the work performed decreases in effectiveness as ocular fatigue increases." The Tuscumbia, Alabama, experiment as reported by Albert (360, 1933: 866-75) and Dates (337) showed that fewer failures occurred and that the pupils were more alert in a schoolroom with adequate illumination, properly controlled.

[1] Bibliography for this chapter begins on page 477.

Johnston (363) reported a student improvement of 28 percent when the illumination was increased to twelve foot-candles properly controlled in the Mt. Lebanon, Pennsylvania, experiment. Controlled illumination in the classrooms, laboratories, and dormitories was accompanied by efficiency and eye conservation in a military school, according to Hitch (358). A summary by Tinker (397) emphasized the value of controlled light intensities, proper color, and adequate distribution in securing the illumination needed for reading. To overcome objections made to the conclusions reached in the Tuscumbia and Mt. Lebanon studies, a later study was inaugurated at Cambridge, Massachusetts. In this study, reported by Allphin (360, 1936: 739-45), the inner row of lights was operated continually, while the other lights were operated by an automatic control cell. Pupils in the controlled room showed 28 percent greater improvement in reading and 10 percent in general achievement than did the pupils in a non-controlled room. There were also fewer repeaters and fewer pupils with defective vision in the controlled room. Brown (360, 1936: 842-65; 1937: 878-905) and Saupe and Elliott (386) reported the inauguration of a three-year test to determine the effect of controlled illumination on scholarship. In addition to the mental and achievement tests, each pupil was given a thorough eye refraction examination at the beginning of the test.

Other tests reported by Layton (365) and by Fleischer and Hoffman (360, 1936: 389-413) gave added stress to the principle that adequate illumination properly controlled and distributed is an important factor in school progress. Harbeson (351) stated that the conservation of eyesight is essential in a modern educational program. Luckiesh and Moss (369) stated that the utilization of proper light to conserve eyesight increases the usefulness of the individual. The importance of adequate illumination is further stressed by Uhler (398), by Cornet (334), and by Luckiesh (370), the latter making a plea for the conservation of sight and the promotion of human welfare through developing a "seeing consciousness." Chamberlin (331) reported that inadequate illumination costs millions of dollars each year. Rodgers (384) stated that it is generally more economical to provide adequate illumination than to increase the size of type in the textbooks or to seat all pupils near the blackboards.

Amount of Light Recommended

The new *American Recommended Practice of School Lighting* (361) called for a substantial increase in lighting standards. It read as follows:

> The first recommendations on school lighting were issued by the Illuminating Engineering Society twenty years ago. Since then two revisions have appeared, reflecting the progress achieved in the technic of improved school lighting. . . .
>
> This new publication . . . was formulated under the rules and procedures of the American Standards Association, by which organization it has been officially approved. In making this revision the sponsor organizations—the Illuminating Engineering Society and the American Institute of Architects—have had the collaboration of the Sectional Committee on School Lighting, a committee which included eyesight specialists, physicians, research workers, public health officials, architects, and engineers.

Approval of the standards by the National Council on Schoolhouse Construction has been delayed pending further investigations of need. Halsey (349) made a comparison of the 1932 standards and the proposed standards of 1937, reporting the following:

	Number of foot-candles recommended in	
	1932 standards	1937 standards
Classrooms	5	15
Sewing room	8	25
Shop	5	15
Gymnasium	3	15
Auditorium	2	6
Locker room	1	4

Other recommendations made in the new *American Recommended Practice of School Lighting* (361) were: the avoidance of direct or reflected glare; light colored wall surfaces; diagonal seating so that no pupil need face the windows; the elimination of blackboards and bulletin boards between windows; and the use of paper without a glossy finish in textbooks.

Eckles (374: 42-47) reviewed certain experiments that were made to determine the proper intensity of illumination. Palmer (380) stated that "it is an established fact that subnormal eyes are benefited to a greater extent by improved illumination than normal eyes." Halsey (349, 374: 18-25) suggested further study to determine the amount of illumination needed. An editorial in *Nation's Schools* (338) suggested further tests and experiments "to determine objectively the lowest intensities of properly distributed and diffused artificial light that can be used in the various parts of the schoolhouse to provide conditions for correct visual acuity and prevent deleterious effects on the eyes." Harrison (360, 1937: 208-23) and Oday and Sturrock (360, 1936: 351-68), while accepting the principle of higher levels of illumination, questioned the advisability of attempting to reach these higher levels without properly designed fixtures to prevent bright spots and glare.

Lighting for Particular Rooms

Special attention was given to shop lighting problems by Sturrock (395). A report on "Special-Purpose Lighting" (360, 1935: 242) indicated satisfactory results with thirty-foot-candle illumination for classes for deaf children. Fuchs (346) stated that classrooms for dramatic work should have no daylight, but should have footlights, border lights, and spotlights. Hathaway (355) cited research to show the need for more window glass area and adequate illumination for sight-saving classrooms. A committee on standards for lighting sight-saving classrooms in Ohio (360, 1937: 807-14) set up ten criteria for evaluating the efficiency of sight-saving classrooms. Some of them were: orientation, glare, diffusion, wall finish, glossy finish, control methods, type of artificial lights, level of illumination, and type of blackboard surfaces. Some of the standards proposed by this

committee were: glass area ratio 20 percent; windows three feet from the floor and six inches from the ceiling; illumination to thirty foot-candles; no glare; special blackboard lighting; automatic control; and a reflection factor of 80 percent for the ceilings and from 50 to 60 percent for the walls. Dates (360, 1934: 866-77) also discussed the value of adequate illumination for sight-saving classrooms. Brown (360, 1936: 842-65; 1937: 878-905) reported satisfactory results from new types of auditorium lighting. He also presented a committee report on the use of sodium and mercury vapor lamps. An article on the "Control of Light" (332) indicated that a proper color balance for drafting rooms may be obtained by blending together the incandescent light and the light of mercury vapor lamps.

Comparisons of Light Quality

The increased interest in lighting has aided in creating a demand for a study of the quality of light and for proper control methods for schoolrooms. Recognizing the fact that daylight may vary in quality, quantity, and value, Tang (360, 1933: 354-73) reported a study made to "determine the relation between speed of vision, visual performance, acuity of vision, and intensity of natural daylight." These tests were made in an illumination intensity of from five-tenths of one foot-candle to ten foot-candles. In order to make a better evaluation of artificial light, Taylor (360, 1930: 154-71) made a study of daylight and weather conditions and the color of sunlight. With the increased demand for artificial lighting in schoolrooms, Ferree and Rand (360, 1933: 376-77) reported three sets of experiments to determine the proper proportions of artificial and natural light desired for classroom use. In a test made in some of the Philadelphia sight-saving classes, Flounders (343) found that the use of synthetic daylight produced by a combination of 500-watt Mazda lamps used in connection with a mercury tube improved the seeing abilities of the pupils. Gage and MacBeth (360, 1936: 995-1022) reported that the light from tungsten lamps can be altered to the luminosity distribution of natural daylight by the use of filters. Luckiesh and Moss (360, 1936: 655-74) stated that "the quality of light, or spectral distribution of energy, is a fundamental characteristic of an illuminant." On this basis they outlined briefly the different qualities of tungsten, mercury, and sodium lights. Likewise, Woodside and Reinhardt (360, 1937: 365-78) made an investigation of the light intensities from, and values of, incandescent filament and mercury vapor lamps. From a similar study Hawkins (360, 1937: 95-106) reported that while the Mazda lamps were more simple and convenient and gave a good quality of light at a low initial cost, the newer vapor lamps were more efficient. He also stated that the use of fluorescent materials may give desirable color effects and greater efficiency. Tang (360, 1931: 258-74) tested the speed of vision limits with daylight used in connection with tungsten and mercury vapor lamps in various combinations.

It is generally understood that the efficiency of artificial light may be affected by many factors such as intensity, location of the luminaries, and

type of control. The methods and value of automatic control were outlined by Sturrock (393), Dearborn (360, 1937: 785-806), Holmes (359), and Frostic (345). Pierce (381) stated that automatic control is economical and that it aids in educational effectiveness. Luckiesh and Moss (360, 1937: 19-60) stated that the foot-candle may be well used as a measure of visibility. Caldwell and Bibber (360, 1936: 613-24) reported an experiment in the Ohio State University developed for the purpose of training illuminating engineers in the principles of light control and illumination. Vedder and Hibben (360, 1931: 517-25) predicted a rather widespread use of automatic control devices for schoolroom lighting.

Factors Affecting Natural Lighting

While a considerable part of the recent research in the field of illumination has been with artificial lighting, it still is true that schools depend on natural light for most of the illumination needed in the classrooms. The amount of natural light available in the classroom may depend on weather conditions as outlined by Taylor (360, 1930: 154-71), architectural design, orientation, fenestration, or by the window blinds used. Teegen (360, 1936: 461-67) insisted that illuminating possibilities should be considered as new building plans are developed. Manning and White (360, 1930: 663-84) gave several examples to show that the installation of reflecting surfaces in light wells aided in providing adequate illumination in rooms facing these courts. Schmidt (374: 36-42) studied the effect of the use of glass blocks in exterior walls. He tested the illumination in classrooms twenty-four feet wide with glass blocks extending from a point eighteen inches from the floor line to near the ceiling. For a northeast room with a glass block area equal to 39 percent of the floor area he reported illumination of from forty-seven to six and one-half foot-candles. He reported some pupil discomfort from the light reflected upward into their eyes. He also found some evidence of eye strain from overillumination or from a lack of control on the sunny side of the building. Harrison and Fouilhoux (352) likewise questioned the value of glass brick in place of windows.

A majority of the classrooms receive their natural light through windows. The type of glass used and the location and design of the windows are therefore important factors in illumination. Carpenter and Viles (374: 26-29) in a study made to check results obtained by Hamon and Taylor (350) found similar variations. Harrison and Fouilhoux (354) questioned the present standards calling for unilateral lighting. The same authors (352) also stated that with the variety of window design and the types of glass available it is possible to attain almost any condition of natural lighting desired. Because of cost and the tendency to deteriorate with age, they questioned the use of glass designed to permit the passage of ultra-violet rays.

Using a photometer, Higbie and Bull (360, 1931: 219-57) tested the light transmission of several types of sheet glass. They found a greater transmission when the smooth face of the glass was next to the light source.

They also reported that dirt collection of prism glass caused a substantial decrease in light transmission. Woodside (360, 1934: 878-94) reported that obscuration and diffusion vary in different types and quality of glass. Sherwood (360, 1937: 665-86) stated that "the advantages of continuous windows lie in superior distribution rather than maximum foot-candles." He also stated that when window glare is not reduced, the occupants may draw the blinds or paint the glass.

In reporting an experiment on seating arrangement in classrooms, Herriott (357) stated that the amount of glare and cross shadows was reduced by diagonal seating. He reported an increased illumination of about four foot-candles on the books of the pupils. Likewise Harrison and Fouilhoux (354) reported the elimination of shadows by a departure from the conventional arrangement of the seating.

Proper fenestration, however, does not always insure adequate daylight illumination. Dark or heavy shades lacking proper adjustment may shut out much needed daylight. From the first of a series of studies on the use of window blinds, Carpenter and Viles (374: 26-29) reported that in a test made of fifteen different materials used and often recommended for schoolroom window shades, only five were sufficiently transparent to give on sunny days a foot-candle reading of fifteen or more on the inside row of desks. They also found in a twenty-one-foot wide classroom, with glass area equal to 18 percent of the floor area, that duck shades on the sunny side of the building may, when fully drawn, reduce the illumination to four or five foot-candles on the inner row of desks. They reported that Venetian blinds seem to lower the light intensity when not in the direct rays of the sun.

Artificial Lighting

During recent years there has been an increasing tendency to supplement daylight with artificial light in the classroom. The single drop exposed lamp fixtures installed for occasional night use are being replaced by new fixtures designed for both day- and night-time use. Illuminating engineers have generally agreed that adequate artificial illumination should be designed to reduce glare to a minimum, and that the light should be so diffused that the student will not be subjected to the eye fatigue of frequent pupillary adaptations to variations of light intensities in the classroom. While these engineers have generally agreed in condemning direct lighting fixtures, they have not been in full agreement on the relative merits and the economy of semi-direct, semi-indirect, and indirect fixtures. Coons (374: 29-31) stated that indirect fixtures produce a uniform and pleasant light over the entire room. Sturrock (394) recommended a wattage increase of 30 percent when indirect lighting is installed. For semi-indirect fixtures Powell (382) recommended fixtures with more horizontal than vertical surfaces. Sturrock (394) recommended that 200-watt lamps be enclosed in sixteen-inch globes and 300-watt lamps in eighteen-inch globes.

Powell (382) recommended the use of thin blown opal glass enclosing globes of sufficient size to eliminate hot spots. Ladd (364), in a lighting survey of eleven University of Missouri buildings, found that metal reflectors on direct fixtures cast shadows on the upper part of the classrooms.

Old lamps and dirty fixtures decrease the available illumination and may cause shadows on the walls or desks. In 143 classrooms, Ladd (364) found that 92 percent of the lamps were dirty. He reported that when the lamps were cleaned the illumination was increased from 16 to 41 percent. Frostic (344) stated that "the factor of maintenance is often overlooked in selecting fixtures. The accumulation of dust on or in fixtures is a matter that must be considered." He reported a 39 percent decrease in efficiency from dirty fixtures. Sturrock (394) and Powell (382) also stressed the importance of keeping fixtures clean.

Glare and color of the light cause many problems in lighting. Ferree and Rand (341) stated that "the clearer vision which is obtained with light properly corrected for color and composition is very helpful to old eyes and eyes having residual refractive errors or defective vision from any cause whatever. . . . At all intensities the eye works with greater precision, speed, comfort, and efficiency under white light than under colored light." Folsom (360, 1937: 734-52) stated that it is possible to reduce glare by the use of louvers to shield against bright spots. Sturrock (394) stated that luminaires for classrooms should be of a type that does not expose the heated filament to view, while Logan (360, 1936: 257-62) indicated that methods used to diffuse daylight may well be used for artificial lighting fixtures.

Effect of Color of Surfaces

The value to pupils of illumination provided for the classrooms is modified by the type of surface and finish of the walls, ceilings, and desks. The New York Lighting Survey Committee (378) recommended that the ceilings of classrooms have a coating of white and the walls of light flat paint. It was further recommended that all pupil desks be given a dull finish. Sward (396) recommended that walls and ceilings be finished with white or light tints of flat paint having a low degree of specular or mirror-like reflection. Gamble (360, 1933: 326-46), in reporting a test on the reflecting qualities of paints, stated that enamels gave about the same degree of reflection as did flat wall paints. He also stated that there is little available accurate data on the effects of different wall paints on the intensity and distribution of light under various schemes of lighting. Early (374: 31-36) cited illustrations from Dearborn (360, 1937: 785-806) of results obtained by a departure from previous conventional color schemes. Early stated that "the recent development of color has taken three directions: (a) color considered as an artistic end; (b) color considered as of artistic significance, but with certain functional duties; (c) color considered first as a light corrector and secondarily from any artistic importance." In commenting on the value of a variety of colors in school-

room decoration, Early cited an experiment made in the Sausalito, California, elementary school where the walls were tinted a graduated bluish grey, the floor blue black, the ceiling white, the blackboards a blue grey, and the Venetian blinds white on the topside and blue on the underside. He stated that the rooms were comfortable and there was no glare. Ferree and Rand (360, 1931: 820-56) called attention to the need for study of color contrasts, or the relation of an object to its background, and visibility with varying intensities of illumination. Powell (382) cited the need for a mat finish and special illumination for blackboards.

Building Design and Lighting

Changes made in the school program and changed building practices have created a demand for special types of lighting. A survey of the available literature indicates that added study is needed to solve many of the problems. Powell and Dows (360, 1930: 882-90) called attention to the need for a study of the light-absorbing qualities of some of the acoustical materials used in many of the classrooms. Early (374: 31-36) reported ample illumination and satisfactory results with the use of skylights in California. He also reported several experiments in the use of sloping classroom ceilings. In an experiment in lighting a windowless office, Beggs and Woodside (360, 1931: 1007-24) obtained excellent illumination but found the cost high. Several investigators have studied the use and value of cove and panel lighting. Higbie and Bychinsky (360, 1934: 206-24) reported satisfactory illumination and a high coefficient of utilization with various arrangements of luminous panels. Lyon (360, 1937: 723-33) in discussing the use of luminous panels stated that "it is possible to design artificial windows and skylights with a luminous efficiency approximating that of the direct luminaires to which we are accustomed, and much higher than that usually obtained with built-in lighting; at the same time, high uniformity of brightness is obtained over the surface." Woodside (360, 1936: 263-76) commended the use of cove lighting. He stated that it is economical and that it gives the desirable effects of indirect lighting.

Bibliographies

Excellent bibliographies have been compiled by Troland (360, 1931: 107-96), Bollinger (329), Smith and Chamberlain (389), Smith and Noffsinger (388, 390, 391), and a Committee on Illumination of the Commercial Technical Group, Special Libraries Association (360, 1931: 611-63). Darley (335) compiled an annotated bibliography on "School Lighting Recommendations Which Are Being Made Today." Attention should also be called to a special number of the "Transactions of the Illuminating Engineering Society" (360, 1938: 301-400) which will be helpful in obtaining a better understanding of the importance of school lighting. The factors which affect lighting and seeing are discussed, including glare, diffusion, color, quality of light, finish of ceiling and walls, dust and dirt, furniture,

natural and artificial lighting, including types, selections, maintenance, automatic photoelectric control, special types of rooms, lighting for safety, and wiring. This general discussion is followed by the light reflection factors for the most commonly accepted acoustical materials as compiled by Smith and Ickis.

Conclusions

An analysis of the available literature on school lighting leads to the following conclusions:

1. During the last five or six years there has developed a new consciousness of the interrelationship of illumination, seeing, and learning.
2. Somewhat higher levels of illumination for classrooms seem inevitable.
3. More adequate controls of light intensities, glare, and diffusion are essential.

Needed Research

The lack of data supported by scientific research indicates a need for research on many lighting problems. Among them are:

1. The use of various types of wall and ceiling paints.
2. The use of window blinds, types, and control.
3. A comparison of the utility, cost, and upkeep of indirect, semi-direct, and semi-indirect lighting fixtures.
4. Illumination standards for various types of school activities.
5. Additional studies on orientation, room widths, and ceiling heights.

CHAPTER V

Cost of School Buildings[1]

HENRY H. BORMANN and N. L. ENGELHARDT, JR.

BIBLIOGRAPHIES prepared by Smith and Noffsinger (416, 417, 418), Smith and Chamberlain (415), Engelhardt, Morphet, and Horton (405), and Alexander and Covert (401), as well as listings in the *Education Index* and the *Industrial Arts Index*, yielded approximately three hundred and fifty references on cost of school building construction. From this group eighty-eight titles were selected which appeared to involve research. On the basis of a critical reading of these studies, thirteen have been selected for report in this summary of research in the field of cost of school buildings, exclusive of finance, maintenance, and operation. Since this is the first time a chapter dealing solely with the cost of school buildings has appeared in the *Review of Educational Research*, a few early references will be included.

A pioneer research in this area is Engelhardt's dissertation (406) of twenty years ago in which he treated costs and ability to pay for school building programs. In 1930 Engelhardt and Engelhardt (404), while not conducting a strict research, presented a broad treatment of school building costs, including classification and distribution of costs, variables influencing costs, advantages and disadvantages of existing measures, and range in costs measured on these bases.

Division of Costs

Coons and Essex (403) analyzed school building costs to find an answer to the question: What percent of the cost of a new building should be called for by each of four major phases—general construction, heating and ventilating, plumbing, and electrical work? Their analysis was limited to one hundred and twenty-four projects in New York State. Extra costs were not taken into account. Furthermore, no attempt was made to group the buildings on the basis of type of construction, facilities provided, or school organization.

The percent distribution of total cost for the one hundred and twenty-four buildings was: general construction, 77.9; heating and ventilating, 12.3; plumbing, 5.3; and electrical work, 4.5. The buildings were then divided into five groups according to total cost, and the percent distribution for each group was determined. It was found that percent of cost devoted to general construction was fairly constant for all five cost groups. Definite trends, however, were evident in other contract costs. Percent of cost of heating and ventilating contracts tended to decrease as total cost of projects increased. The range was from a high of 14.0 percent for the group of smallest projects to a low of 10.9 percent for the group of largest projects. The trends for plumbing and electrical contracts were just the opposite.

[1] Bibliography for this chapter begins on page 480.

As total cost of projects increased, percent devoted to plumbing increased from 4.4 to 6.4 and percent expended on electrical work increased from 2.9 to 5.1.

In explaining these trends, Coons and Essex (403) concluded that simplicity of heating and ventilating systems installed in small buildings tends to reduce costs, but the relatively large expenditure necessary for the boiler plant overbalances this tendency, resulting in higher percents of total cost for heating and ventilating contracts on small projects. In small buildings plumbing work is limited to water supply, toilet facilities, and sewage disposal system; in large buildings the sewage disposal system is usually inexpensive because it is usually tributary to a city system rather than independent, but additional expenditures are incurred in larger projects through specification of plumbing equipment of higher quality and through inclusion of added facilities, such as showers, toilets in shower rooms, toilet accommodations for teachers' room, principal's office, and janitors' room; toilets for public use in gymnasium and auditorium, toilets for special rooms and shops, plumbing equipment in special rooms, laboratories, and shops; and complete roof water and yard drainage. Electrical costs also tend to increase in the same way as those for plumbing. Character of electrical equipment specified for larger buildings differs from that for smaller ones through the inclusion of telephone system, radio system, visual instruction equipment, time clock and program bells, central switchboard, temperature control equipment, emergency lighting, and shop, laboratory, and homemaking equipment.

In spite of the separation of the one hundred and twenty-four buildings into five groups on the basis of cost, the ranges in percents of costs for various construction contracts were wide, in some cases almost as great as the range for all the buildings together. This is due to the fact that general construction costs are affected by types of materials specified and by architectural design; heating and ventilating, plumbing, and electrical costs are dependent upon the amount and character of service installation.

Unit Costs

In an unpublished master's thesis Vincent (419) presented data for more than one hundred elementary-school buildings, widely distributed over the state of Texas, as shown in the table on the following page.

Morse and Anderson (412) presented comparative cost data for 228 elementary- and high-school buildings, built since 1921, on the basis of type of building, median cost per pupil, median cost per square foot, and median number of square feet per pupil. The New Jersey formula for determining unit costs is described as follows:

> In New Jersey we recognize three methods of determining costs, namely, per pupil, based on the maximum pupil capacity, per square foot of usable floor area, and per cubic foot. The maximum pupil capacity will vary according to the educational system used or type of school housed. The number of square feet of usable floor space is the best factor to use in determining unit costs of school building construction, providing the factors are the same.

In any comparison of school building costs the time of construction is an important factor because prices of labor and materials tend to vary. Clark (402) was one of the first to study the influence of price fluctuations by means of index numbers.

Unit Costs for Construction of Elementary-School Buildings (419)

Unit	All buildings studied	One-story buildings	Two-story buildings
Cubic foot costs:			
High	$.34	$.27	$.34
Low	.093	.093	.179
Mean	.196	.169	.237
Median	.211	.173	.222
Number of buildings	114	56	58
Square foot costs:			
High	$4.71	$4.13	$4.71
Low	2.22	2.22	3.15
Mean	3.64	3.38	3.84
Median	3.76	3.59	3.83
Number of buildings	104	60	44

Variation in Bids

Pugmire (413), who compared 227 general construction bids, 235 heating and ventilating bids, 148 plumbing bids, and 174 electrical bids on twenty-five buildings, reported that 22 percent of the bids on general construction contracts involving $200,001 to $500,000 were 21 to 50 percent higher than the lowest bid; that 21 percent of heating and ventilating bids of $20,000 or less showed a similar variation; that this variation appeared in plumbing bids in 75 percent of those of $10,000 or less, 35 percent of those ranging from $10,001 to $50,000, and 44 percent of those over $50,000; and that the same variation—21 to 50 percent above the lowest bid—was found in electrical work in 38 percent of the bids of $10,000 or less, 24 percent of the bids of $10,001 to $50,000, and 29 percent of bids over $50,000.

Fire Resistive Building

In order to obtain accurate data upon the respective costs of fire resistive and ordinary construction, the board of education of Rochester, New York, secured bids on three complete sets of plans and specifications. Scherer (414) reported that a fire resistive building would cost less than 6 percent more than the same building of ordinary construction.

Cost and Amount of Building

Holy and Arnold (410) studied school building expenditures in Ohio in relation to economic conditions throughout the country. They found a

great decrease in the amount of bond issues proposed and approved between 1928 and 1931. An analysis of amounts expended annually for school buildings and grounds in Ohio from 1915 to 1930, inclusive, revealed that as the index of construction costs went up, the amount of building increased, and as building costs fell, the amount of building decreased.

Extra and Incidental Building Costs

Misner (411) studied the causes of extra costs and incidental costs. He found that certain general causes underlie the more specific causes.

> In general, the boards of education did not attach sufficient importance to the preliminary work of an educational nature which should have been done before the architect was called in. This function should have been performed by trained educators, and thoroughly worked out to the end that the architect was furnished with a complete statement of spaces as soon as he was commissioned. Many extras resulted from failure to follow this procedure.
>
> Some boards put a premium on low estimation of costs by the competing architects while selecting the architects. Bonds were issued on the basis of these estimates. After bids came in it became necessary to revise plans somewhat and to eliminate certain features, with the result that there were inconsistencies between various phases of the plans and specifications. Architects cannot guarantee costs of materials months in advance, and boards of education should not ask them to do so.
>
> In many cases the architects were allowed insufficient time by the boards of education between the time of their selection and the date when contracts were let. This lack of time resulted in insufficient study of the educational needs upon which the plans were based, and, consequently, in inconsistencies in and omissions from the plans and specifications. Schoolboards should allow architects a reasonable amount of time in which to develop plans and specifications.
>
> Finally, in a number of cases, the development of the building plans was worked out very largely by the architects and the board, or members of the board, who thus usurped some functions which should have been performed by educators. The consensus of informed opinion is that the best results are possible only by close cooperation between educator and architect.

Misner concluded that the major portion of extra costs not covered by unit prices could have been prevented. He also found that the majority of boards of education made no systematic attempt to anticipate and provide for all the costs connected with their building programs. Records were incomplete and many items of incidental expense were paid out of current funds rather than building funds. He recommended that all possible items of incidental expense be listed in advance and provided for in the capital outlay budget. A checklist of items of incidental expense is included in the study.

Essex (407) analyzed school building cost reports from 66 central rural school districts in New York State to determine items involved in incidental costs and their relation to costs of construction. Order of frequency of items reported was as follows: architects' fees, 66; legal services, 62; legal advertising, 54; engineering services, 41; printing bonds, 31; insurance on building during construction, 25; clerk of the works, 21; fidelity bond, 6; and depository bond, 5.

Essex assumed that legal service and legal advertising were not listed in certain cases merely because local officials had failed to report these costs; that engineering service was sometimes furnished by the architect; that attorney's fees sometimes covered printing of bonds; and that costs representing insurance on a building during construction, clerk of the works, fidelity bond, and depository bond were absent because boards of education failed to appreciate the value of these forms of protection.

Ratios of incidental costs to total cost for each project, expressed as percents, ranged from 4.9 to 10.6 percent, with a median of 7.1 percent. Incidental costs tended to increase slightly with cost of project.

To determine, so far as these data permitted, the percent of total construction costs which might reasonably be applied to incidental costs, the median percent for each item of incidental expense was determined as follows: architects' fees, 6.0; legal services, 0.6; legal advertising, 0.1; engineering services, 0.15; printing bonds, 0.1; insurance on building during construction, 0.25; clerk of the works, 0.8; fidelity bond, 0.2; depository bond, 0.5. A total percent obtained as a sum of median percents for the several items was 8.75.

Essex made no attempt to evaluate present practices giving rise to incidental costs. He recommended 10 percent of cost of construction as a wise allowance for incidental costs.

Blackboard Costs

Hart and Peterson (409) reported on pupil use of blackboards in junior and senior high schools. Data assembled showed actual use made of blackboards in 294 regular classrooms and 100 laboratories and special rooms over a period of five school days. The largest number of pupils using the blackboards at any time in a particular room was taken as the minimum amount of blackboard space needed for a certain subject taught. Conclusions were drawn and recommendations made on the basis of evidence of need in terms of use. Forty percent of all blackboards now installed in junior and senior high schools might be removed without imposing any handicap upon instruction. In the 394 rooms studied, a net saving of $33,700 might have been effected through the elimination of excessive and useless blackboard installation.

CHAPTER VI

Foreign School Buildings[1]

N. L. ENGELHARDT and BLAKE COCHRAN

EVIDENCE OF A GROWING INTEREST in foreign school buildings is found in numerous articles which appear in American publications (421, 422, 424, 434, 437, 447, 448, 449). Very little real research, however, has been done in this area. Most of the material which is available is descriptive and not systematic. The one notable exception is the publication of the International Bureau of Education at Geneva (420). This document was compiled from a questionnaire sent to thirty-eight countries. It is concerned with legislation which has to do with the construction of school buildings in the central and provincial governmental units of the various nations. Particular attention is given to site, location, lighting, ventilation, heating, dining halls, sanitary facilities, gymnasiums, gardens, and playgrounds. In addition to the reports from the countries to which the questionnaire was sent there is a general discussion of the information received.

If any one trend could be held to characterize the studies of foreign school buildings, it would be the opening of the buildings to the sun and fresh air, and the provision for life in the stimulating out of doors. An admirable statement of this trend is found in Minnuci's *Scuole* (450):

> The ideal school should offer to the child an outdoor training. The school should call them for many daylight hours, not to seclude them in large buildings much like prisons, but in order to make them live in orderly freedom, in the open air, in the sunshine, and in contact with divine nature.

An article in the *Architects Journal* (423) indicated that the same trend may be observed in the English schools.

In addition to the publication of the International Bureau of Education (420) there are several magazine articles which give an over-all picture of developments in foreign school buildings. Davis (421) discussed schools for young children in Austria, Poland, Union of Socialist Soviet Republics, the Netherlands, Czechoslovakia, and Great Britain. Her most important findings were concerned with site requirements, room space per pupil, temperature, equipment, decoration, and special features for the use of young children. An article in the *Architectural Forum* (422) presented photographs and plans of the most modern schools in Egypt, Italy, France, Austria, Germany, Union of Socialist Soviet Republics, Mexico, and England. A similar article appeared in the *Architects Journal* (423). Woodbridge (424) made a study of European schools from the point of view of an American architect, pointing out the European ideas in school building construction which should be of value to the American architect.

[1] Bibliography for this chapter begins on page 481.

Denmark

A League of Nations report in 1931 prompted the appointment of a commission to investigate hygienic conditions in the schools in Denmark. The recommendations made by this committee (425) were concerned with the types of school buildings, the sports place, the workshop, the school kitchen, and other building features which affect school hygiene. Two articles which appeared in school numbers of the *Arkitekten* (426, 427) gave some evidence on the present trend in school building planning in Denmark. Both articles were illustrated with reproductions of photographs and plans of school buildings. The *Arkitekten* indicated that brick is the favorite building material in Denmark; the Danes feel that it is particularly well adapted to their landscape. The buildings are in the main simple and compact.

England

Suggestions for the Planning of New Buildings for Secondary Schools (431) and *Suggestions for the Planning of Buildings for Elementary Schools* (430) published by the board of education were the most interesting studies concerning school buildings in England. An impression of the attitude of the board of education toward school buildings may be found in a discussion of the general considerations of planning given in the first-named pamphlet.

> The architect's problem is to open up as far as possible every part of the school building to the air and sun, to provide free cross ventilation, natural lighting and suitable temperature, and at the same time to keep the area of the building within a reasonable compass so as to avoid the sacrifice of too much of the site. . . . The design should be well balanced but symmetrical elevations should always give way to convenience in the plan.

Both pamphlets discussed types of structure, building materials, site requirements, special rooms, classrooms, gymnasiums, halls, and other features of school buildings. Freedom in planning schools to meet local needs is a characteristic of the English system. The board of education is careful to explain that it is making suggestions and not setting forth regulations.

The book by Clay (429) was the most extensive English study concerning school buildings. His suggestions for the construction of elementary and secondary schools were based on both experience and opinion. The sections concerning heating and ventilation are the most valuable parts of the book. A pamphlet published by the National Union of Teachers (432) reported the results of some studies in heating, lighting, and ventilation. While they are not research in the strictest sense of the word, the *Architects Journal* started an interesting series of articles in November 1937 which ran until January 1938 (428). Photographs and reproductions of plans of many school buildings, both public and private, make these numbers a valuable source of information to the student of

foreign school buildings. In the general discussion which appeared in the initial article of the series the most important trends in English school buildings were identified.

France

The Glass School at Suresnes which has been given a great deal of publicity in America is described by Beaudouin and Lods (434). The school is an excellent illustration of the extensive pavilion plan which permits maximum benefit from natural light. The construction and equipment of schools to meet the needs of infants were considered by Brès (435). *Écoles* by Poulain (438), though not recent, contained many interesting reproductions of photographs and plans of French schools. Students interested in building legislation may wish to read the school building regulations for the city of Paris which were given in this study. A concise statement of the distinctive features of the new elementary schools in Paris with contrasts with American schools was found in Engelhardt's article (437).

The May 1935 and 1936 numbers of *L'Architecture D'Aujourd'hui* (433, 436) contained articles beautifully illustrated with photographs and plans of school buildings. While most of the illustrations were of French schools some of them were of outstanding examples of school construction in other European countries. The construction of many of the new French schools is on quite modern lines, developed with a typical finesse which commends our admiration.

Germany

As is true of the other countries mentioned above, research is not characteristic of the literature reporting on German schools. Much, however, has been written about school developments of the past two decades in Germany. The architects of this country have been leaders in the development of modernistic architecture and in the planning of schools with a maximum of sunlight and ventilation. German schools are also frequently planned to make possible the use of outdoor classrooms, instruction in gardening, and liberal provision for play.

The outstanding book showing these developments is *Der Neue Schulbau* (445). The publishers are planning a new edition which will be issued shortly. This volume also illustrated school planning in other lands.

The study by Hane (441) presented a very detailed statement on standards for school building construction. All aspects of buildings were treated. *Das Neue Schulhaus* (442) is another comprehensive volume on the construction and equipment of school buildings. It contained detailed drawings to illustrate standards. Illustrations of exteriors and interiors of recent construction were also presented. Minnuci's *Scuole* (450) and Poulain's *Écoles* (438) gave generous space to the portrayal of German schools.

Schütte (443) discussed the underlying educational theory and corresponding architectural theories involved in the building of new schoolhouses in Germany. This article was accompanied by splendid illustrations of new schoolhousing.

German magazines like *Bauwelt* (440), *Der Baumeister* (439), and *Stein, Holz, Eisen* (444) frequently contain articles discussing new building construction in Germany. Such articles are usually accompanied by illustrations.

Italy

Certainly the most interesting volume concerning the Italian schools was by Minnuci (450). While it did not attempt to give an analysis of the status of school buildings in Italy, it discussed standards of construction, indicated some of the most progressive trends, and presented illustrations of modern schools in Italy. The facilities of the "Opera Balilla," or youth movement, which complement those of the school, are described by Minnuci. This movement, which promotes a kind of spiritual, cultural, physical, and military training for youth between the ages of six and eighteen, has developed some striking examples of the use of modern design in educational structures. In addition to the Minnuci study, the volume by Secchi (451) gave an extensive discussion of Italian school buildings. These two books offered an interesting contrast by showing the developments in school building construction which took place during the decade which elapsed between their publication dates.

Three articles by Engelhardt (447, 448, 449), descriptive of particular schools, are valuable for indicating some of the best practices in Italian schools. One of these articles (449) described a school to meet the needs of weak children. A short discussion with numerous photographs and plans of Italian school buildings was given in *L'Architectura Italiana* for March 1935 (446). This magazine does for the Italian schools what *Architects Journal* (428) does for the English, and *L'Architecture D'Aujourd'hui* (433, 436) for the French.

Netherlands

The study by Rothuizen, Kockx, and Brants (452) contained quite an extensive discussion of the typical problems in school building construction, and contained regulations for their construction. While some sections of this study are outmoded, there is still much of interest in it. The more recent trends in building construction in the Netherlands was shown by Yerbury (453). The school at Hilversum designed by W. M. Dudok, and the school at the Hague designed by J. Limburg, were included in the building plate reproductions. Both are examples of "the new architecture," and show the use of mass relieved with splashes of bright color and unusual arrangements in form. The multitude of references to the Dutch schools made by writers of other countries indicated that innovations in the

Netherlands merit the attention of those interested in school building planning.

South America

Readers interested in the study of schoolhousing in South America will gain much help from the Pan American Union, Washington, D. C. No outstanding research on school buildings is reported from South America. The *Bulletin of the Pan American Union* (454) is published monthly and frequently contains articles on the schools of the various countries of South America, with illustrations. For example, the article entitled "Intellectual Cooperation between the Americas" in the April 1931 issue was illustrated with types of South American educational buildings. The January 1932 number contained an article on "Educational Beacons in Colombia." The April 1935 issue had an article on "The Second Inter-American Conference on Education" accompanied by illustrations.

The *Revista de Las Indias* (458) showed plans in considerable detail of a new university building in Bogota. Other significant references to school buildings in Latin America appear in the bibliography for this chapter (455, 456, 457, 459).

Sweden

There has been no dearth of books and articles within recent years concerning Sweden, but there has been very little published information specifically concerned with Swedish school buildings. The literature which is available is not recent. *Folkskolebyggnader* (461) which contained building regulations and reproductions of plates of elevations and floor plans was important largely for background or historical purposes. A publication of the Royal Department of Education (460), which set up norms for the construction of school buildings, considered the locations of the school, school law, special rooms, teachers' homes, adjacent buildings, play spaces, school gardens, and school equipment.

CHAPTER VII

Technics of School Building Surveys[1]

WILLIAM E. ARNOLD

CERTAIN ASPECTS OF THE SUBJECT of this chapter have been treated in the issues of the two preceding cycles of the *Review of Educational Research* which dealt with the school plant. The same topic was also discussed in one chapter of the issue of February 1934 on "Methods and Technics of Educational Research." It will therefore be the purpose of this chapter to review only those studies appearing since, or which were omitted from, previous treatments in the *Review*.

Nature and Scope of Building Surveys

The following statement from Sears (474) regarding the school survey as a phase of educational research may be applied equally well to the school building survey: "The school survey is a specialized type of educational research, the goal of which is the improvement of school practice. . . . As a form of educational research the survey is novel in several respects. It originates in practical difficulties by governing authorities. . . . The task of the survey is not so much to discover entirely new facts and principles, as is the case in general research, but rather to solve some practical problem. . . . In method the survey usually cannot pause long enough to take advantage of experimentation; it often must study processes where academic research could experiment and await opportunity to study product. As in medicine, the survey is expected to diagnose and to prescribe remedies, and above all, it must not injure the patient. Further, since the patient is to administer the remedies, both diagnosis and prescription must be fully explained in a report."

In the December 1932 issue of the *Review of Educational Research*, corresponding to the present issue, ninety-two studies dealing with the school building survey were reported under the following classifications: (a) character of the community; (b) school population; (c) appraisal of the existing school plant; (d) the plan of organization and educational aspects; (e) the ultimate school plant; and (f) the program of finance. These topics suggest the general scope of building surveys.

Caswell (464) analyzed a large number of studies generally regarded as surveys in an attempt to define their peculiar characteristics. He concluded that a study, to be classified as a product of the modern survey movement, should have the following four characteristics:

1. Present or proposed practices or programs are questioned.
2. A comprehensive study and evaluation is made of the status of all factors relating to the practice or program questioned.

[1] Bibliography for this chapter begins on page 483.

3. Both immediate and future needs are stated as they are indicated by the status study and research findings.
4. Practices or programs are outlined to meet these needs.

The same writer (465) traced the development of important aspects of survey development through an investigation of seventy surveys which dealt with school buildings. As a result of his study he recommended the following outline of the problems that should be given consideration in school plant surveys:

1. Present school plant
   a. Analysis of each building—sites, building, service systems, classrooms, special rooms
   b. Building utilization
   c. Renovation program.
2. Educational program in relation to buildings
   a. Type of school organization
   b. Curriculum offerings
   c. Persistence of pupils in schools.
3. Future building needs
   a. Population trends—growth in school enrolment, growth in city population, births by areas for years
   b. Residential development—residential saturation, location of new homes, where children live, population centers, industrial areas.
4. A building program with definite steps of development for elementary schools, junior high schools, senior high schools.
5. Financing the building program
   a. Financial requirements of the program
   b. Ability of the community to support the program
   c. Procedure to be followed in financing the program.

Wood (476) formulated seven characteristics of a good survey report as follows:

1. Individuality. It is an accurate picture of the particular system under consideration, not a modified picture of some other system.
2. Objective. It shows no evidence of a predisposition to voice personal views or opinions. Its object is to present facts.
3. Without unnecessary detail, it presents in clear perspective all of the essential facts and factors that will prove serviceable in justifying existing procedure or in solution of new problems of interest and concern.
4. Its form is direct, clear, intelligible, and logical.
5. Its tenor throughout is constructive in character and effect, never capricious.
6. It bears upon its face evidence of thoroughness and accuracy.
7. It presents a carefully elaborated summary or exposition of the application that is to be made of the findings.

Holy (471), in describing the school building surveys conducted by the Bureau of Educational Research of Ohio State University, reported that:

The surveys include a study of the character of the community, school organization, school population, status of present plant, school building needs, and the financial condition of the district. Among the items mentioned under these main divisions are the estimated future school enrolment, used as the basis for arriving at school building needs; the utilization of the present plant indicating to what extent the buildings are overcrowded; the residence location of the pupils of each grade; an analysis of the assessed valuation and bonded indebtedness of the district as compared with that of

districts of about the same size to determine the ability to finance a program; and recommendations on the location, size, and cost of buildings.

The Cincinnati public schools (467), with the help of a Works Progress Administration staff, have recently completed a fact-finding survey of the physical plant, including sites, buildings, equipment, and apparatus. The report included detailed measurements and specific enumerations of many aspects of the plant. Many of the findings are reduced to ratios and percents of various kinds. This survey differs from the usual building survey in that it is strictly of the cross-section or inventory type, involving no element of appraisal such as is common in surveys made by outside organizations.

Organizations Making Surveys

Holy (470) described in considerable detail the procedures used in school plant surveys under two types of organization: (a) those in which a group of survey specialists are called in from the outside for the purpose of directing the survey, and (b) those in which the survey is developed by persons within the system. It might be added that the first procedure is much more common, owing largely to the provision for such service by an increasing number of state departments of education and state universities. Carpenter and Rosenstengel (462) made a study of the extent of school plant surveying done by state universities. They found twenty such universities which conduct school plant surveys. In eight universities the school plant survey is made by the department of school administration; in three, by the bureau of research whose function is limited to surveys and advice; in three, by the college or school of education; in one, by the bureau of research whose function is general; in one, by the bureau of tests and measurements; and in one, by the department of rural education. The reported tendency was to have regular faculty members conduct the school plant survey although in nearly all of the universities studied graduate students were used for the collection of data.

School Building Appraisal

An analysis of the factors to be studied in appraising an existing school plant was made by Moehlman (473). He stated that there are seven large groups or divisions of factors upon which each individual school building should be appraised both in its own relative and immediate existence and in terms of its relation to the larger community plan. He included the factors of mechanical efficiency, instructional efficiency, space efficiency, location, site, current use, and possible future use. He made a thorough analysis of each factor together with criteria to be used in evaluating it.

Caswell (466) analyzed fifty-one comprehensive surveys made between the years 1914 and 1930. He stated that ". . . considering both the methods of securing and of treating data and the bases of evaluation, it is clear

from this analysis that since the early years of the survey movement there has been a marked tendency for surveys to employ increasingly objective technics. Even yet, however, the judgment of members of survey staffs is employed in evaluating data for the solution of many problems."

In the same study he reported that seven was the average number of problems treated in the school plant sections of twenty-two comprehensive city school surveys made since 1924. He further analyzed the methods of securing and evaluating data as follows:

Method of securing data	Percent of times employed
Analysis of available basic data	38
Score-cards and rating scales	44
Observation	18

Method of evaluating data	Percent of times employed
Comparison of units in the system	1
Comparison with comparable cities	8
Comparison with neighboring cities	3
Comparison with generally accepted standards	1
Score-card and rating scale standards	44
Research results	1
Judgment of survey staff	22
Interpretation of trends	20

The use of school building standards and score-cards, utilization forms and formulas, has been treated in previous issues of the *Review*.

Predicting Building Needs

A device not previously reviewed is a method of planning for new school buildings by means of graphic records, developed by Irons (472). After a number of years of experience and research in Cleveland, Ohio, he developed a system of graphical enrolment records and a method of using them which he found to give the best indications of the probable enrolments in the immediate future. The method is similar, on a smaller scale, to that employed by the Bell Telephone Company in their nationwide surveys and predictions.

Survey Outlines

From their wide experience in conducting school surveys Strayer and Engelhardt (475) have prepared a detailed list of the procedures to be followed in the development of a survey which includes school buildings. Carpenter (463) arranged a school building survey work sheet which covered three specific assignments or jobs: the present school plant, a study of population, and the ability to finance a building program.

Comparative Costs

Halsey (469) stressed the need for a definite and reliable basis of cost comparisons between school buildings. He criticized a number of common

methods and stated that "the square foot of floor area, the square foot of ground area, the cubic foot, the classroom or classroom unit, are all measurements of construction in units or parts of the construction, and their costs are costs of construction only. They do not give us what we need to know to make a fair comparison between the costs of schoolhouses, and that is the cost of the use unit. The use unit of the building is the pupil. . . . It seems evident that the proper unit to be used in cost comparison of schoolhouses is the cost per pupil station."

Secondary-School Standards

Mention should be made here of the comprehensive program of the Cooperative Study of Secondary-School Standards (468). This project, under the direction of the six regional associations of colleges and secondary schools, has recently completed an intensive survey of two hundred secondary schools throughout the country. One part of the study was devoted to an evaluation of the school plant. The procedure used was in the form of a checklist organized on a functional basis, the emphasis being on the usefulness of the plant from three important points of view —according to its tendency to promote health and safety, economy and efficiency, and the general educational program. The results of the use of this device in the cooperative survey have not as yet been published but the committee in charge is now working on the validation of the checklist.

CHAPTER VIII

Plant Development for Higher Education, Including Junior Colleges[1]

RAY L. HAMON

AN ATTEMPT is made in this chapter to list the research and some of the more significant articles published on university, college, and junior college plants since October 1935. There has been very little objective research in this field, although much of the research on school lighting, heating, ventilation, landscaping, maintenance, and construction standards of public schools apply also to college plants. During the past three years many articles on college and university buildings have appeared, but, for the most part, they have dealt with individual buildings, or with plant layouts of individual institutions. Very little of this material is of a research nature, and it has been omitted from this review. Neither does this chapter include the many college plant surveys which are in manuscript form for the guidance of local institutions.

Library Facilities

Eells (485) reported a study of junior college libraries by the Carnegie Advisory Group. From the 288 replies this study revealed that the median junior college library is housed with the local high-school library, that it seats 75 readers, and has 744 feet of shelving. Hanley (489) recommended that there be 100 square feet of work space in college or university libraries for each staff member and submitted several floor plans of university libraries. *The Library Journal* (505) published a summary of some of the more recent developments of physical plant facilities for college libraries. Randall (502) gave an excellent treatment of housing the book collection and arranging the stack rooms. He suggested that the stack capacity be planned for double the number of books in the collection at the time the building is erected. Tilton (506) presented an excellent discussion on library planning in which he pointed out the disadvantages of circular reading rooms and dealt with the organization, size, equipment, stacks, reserves, and accessory rooms for college and university libraries.

Science Facilities

The Chemical Foundation of New York (501) published a significant report on the construction and equipment of chemical laboratories by a Committee of the National Research Council. Coleman (483), in his article on the new Mellon Institute Research Laboratories, gave a detailed discussion of procedures in planning and constructing a laboratory building. He dealt with materials used and types and arrangements of

[1] Bibliography for this chapter begins on page 483.

plumbing, wiring, ventilating ducts, storage facilities, and laboratory desks. Cunningham (484) reported a research study of the biology departments of ten teachers colleges and made recommendations as to layouts, windows, color schemes, equipment, and supplies for laboratories, lecture rooms, and recitation rooms. Foulk (487) published a discussion of two methods of distributing laboratory supplies for college science, the central delivery system, and the small or individual laboratory supply storage. He discussed at length the Princeton system which is a combination of the two. Hoover (492) reported for the National Research Council Committee on the importance of architects, administrators, and science teachers devoting much time and thought to the planning of laboratories for college science. He stated that careful planning will result in more usable facilities and save future expensive plant alterations.

Physical Education Facilities

Hadden (488) made a questionnaire study of a number of colleges for women to determine the relative usefulness of various gymnasium facilities and activities. Blewett (477) conducted a study of the administrative responsibility for the maintenance of college outdoor athletic facilities, which resulted in the University of New Hampshire's placing this responsibility under the director of athletics with a separate budget for this purpose. Reid (503) described cork-surfaced tennis courts at Colgate University where they have proved very satisfactory and superior to hard-surfaced courts. The University of Michigan, in cooperation with the State Highway Department, is conducting an experimental study of tennis court surfacing.

Junior College Facilities

Carpenter (479, 480) studied the junior college plants constructed since 1925 and tabulated data secured from state superintendents on location, type of control, purpose, grade levels, and types of construction for one hundred and seventy-two buildings in ninety-seven junior colleges. Carpenter (481) also stated in another article that relatively few junior colleges have been constructed for junior college programs, and that most of them have been planned for the traditional secondary school. He set up principles for planning a junior college plant. Chamberlain (482) studied thirty-two junior colleges to determine the problems involved in housing a junior college. He included such problems as functions, class size, schedules, special facilities, sites, and dual housing. He set up standards based on present practice and drew conclusions from the consensus of administrators. Junior college literature contains many descriptions and pictures of individual institutions and buildings. One of the most illuminating of these is Harbeson's article (490) on Pasadena's million dollar program.

Student Housing

Bozorth (478) made a plea for architects designing college dormitories to cooperate with persons experienced in dormitory management. Walford (507) gave a good illustrated discussion of the use of small units or group housing in college dormitories. Ingemann (494) discussed lower costs in dormitory construction, the tendency toward a narrower or thirty-foot building, and the elimination of corridors. The student union was defined and its facilities listed in an article by Hartenstein, Butts, and Lauterbach (491) in which they used data from a questionnaire study by the Association of College Unions.

Landscaping

Hubbard and Zach (493) showed several attractive campus layouts and discussed some of the principles of campus planning. From questionnaires they attempted to determine the ultimate space requirement of each division and department so as to allow for future expansion. F. W. Johnson (495) presented an illustrated article showing how Colby College has planned a plant to house a curriculum and is placing it in the middle of a six-hundred-acre campus. Laverty (499) presented a plan for college campus maintenance recommending how grounds should be kept and the organization and equipment required. Shepherd (504) said that "landscape development should not be considered as a last minute trimming, but as an integral part of the entire program of providing for a satisfactory educational center."

General

In 1936 *The American School and University* (500) contained an excellent selected bibliography of outstanding books on school buildings.

Evenden, Strayer, and Engelhardt (486) have in preparation a book of standards which promises to be a classic in the college plant field. These standards are to be used in connection with the Evenden-Strayer-Engelhardt *Score-Card For College Buildings* published in 1929. This book will be similar in nature and scope to the Strayer-Engelhardt standards for elementary- and secondary-school plants.

F. B. Johnson (496) set up a system and proposed procedures for the operation and maintenance of a large university plant. With modifications for size of organization and local conditions, the proposed procedures offered an excellent guide for the repair and janitorial programs of institutions of higher learning.

Kissack (497) presented excellent illustrations and discussions on how to provide adequate physical facilities for visual education in colleges, including the production, storage, and use of visual aid materials.

Kraehenbuehl (498) reported on study lighting at the University of Illinois, where he scored the effectiveness of various types of lighting fixtures and study lamps.

CHAPTER IX

Pupil Transportation Equipment[1]

C. D. HUTCHINS

Material Available

THOSE RESPONSIBLE for the administration of pupil transportation are able to take advantage of the extensive amount of research relating to automotive equipment. The study and development in this field, for the improvement of motor vehicles generally, is directly useful in the manufacture of school bus equipment and is instrumental in the production of safer, more efficient, and more economical motor vehicles for the comfortable transportation of school children. No attempt will be made here to cite the extensive research relating to the development of automotive equipment; such research can be found in publications prepared for chassis and body manufacturers. This review will, however, touch upon that research which relates more specifically to the use of motor vehicles in the transportation of pupils.

Bulletins relating to pupil transportation service have been prepared and printed in most of the forty-eight states. The material has usually been assembled by some one in the state department of education and frequently chapters are included which relate to equipment. In these chapters many opinions and recommendations are expressed, but there is little evidence to show that these are based upon facts. Absence of extensive research in this field is due more to the fact that findings have not been printed rather than to the lack of interest in school bus equipment. For instance, at Ohio State University alone, approximately thirty masters' theses have been prepared in the field of pupil transportation.

It is recognized that an extensive amount of research on school buses may not be necessary since the ready-made equipment is available to school authorities, having been developed through careful and technical research on the part of engineers. From this point of view those interested in schools are in the fortunate position of having the work done for them by the motor vehicle industry. It is believed, however, that much more research than is available should be carried on by those interested in pupil transportation to determine the relationships existing between the various characteristics of school bus equipment and satisfactory school bus service.

Motor Buses Prevail

Studies relating to school bus equipment scarcely need to deal with any other subject than motor buses. Some years ago, horse drawn vehicles were used extensively but they probably will be used so rarely in the future that research relating to them would be of little benefit. Johns (512) indi-

[1] Bibliography for this chapter begins on page 485.

cated in his study prepared in 1928 that 95 percent of the pupils in Florida who were transported to school rode in motor buses. Belknap (508) reported that of the 7,434 conveyances in daily use during 1936-37 in New York State, only 447 were horse drawn. The study of pupil transportation in Iowa recently completed by Williams (524) indicated that there are only 328 horse drawn vehicles out of a total of 2,887 which provide the pupil transportation service for that state, and even in these cases motor vehicles are substituted in favorable weather.

Age of School Bus Equipment

Opinions expressed in state departments' bulletins on pupil transportation indicate that school buses are used too long. There is no research available which offers any conclusion regarding an optimum period of service for a school bus. Some figures, however, have been made available which indicate the ages of school buses now in service. Noble (517) found that of 1,254 buses which operated in North Carolina during the 1930-31 school year, 368 (29 percent) were less than three years old, 440 (35 percent) were from three to five years old, and 446 (35 percent) were more than five years old.

In Ohio (518) the buses which operated during the 1936-37 school year were manufactured during the years listed in the following table.

School Buses Used in Ohio in 1936-37

Year of manufacture	Number of buses	Year of manufacture	Number of buses
1924	92	1931	731
1925	57	1932	532
1926	122	1933	408
1927	222	1934	558
1928	463	1935	619
1929	739	1936	947
1930	951		
		Total	6,441

All Metal Construction

Gradually the schools are demanding that the school bus bodies be made of steel and other metals of similar strength. This trend is in accord with the general opinion that railroad cars and automobiles should be constructed of steel for safety. Accidents involving steel buses are believed to result in fewer injuries and deaths than those which involve wood or composite construction. Reynolds (521) found that 141 of the 1,053 buses used in Kentucky during 1935-36 were of all steel construction.

Cost of School Buses

Evans (511), in his study of school transportation in California in 1929, found that the purchase price of 565 buses, including 21 different makes,

ranged from $450 to $8,705, with an average price of $3,644.67. These cost figures for California are much higher than the amounts paid for school buses in Ohio (518). The following table lists the number of board owned buses in Ohio during 1936-37 in the various price ranges.

Cost of School Buses in Ohio in 1936-37

Cost of bus	Number of buses	Cost of bus	Number of buses
$3,000—up	69	$1,600—$1,799	181
2,800—$2,999	19	1,400— 1,599	241
2,600— 2,799	36	1,200— 1,399	276
2,400— 2,599	32	1,000— 1,199	278
2,200— 2,399	56	800— 999	53
2,000— 2,199	65	To— 799	213
1,800— 1,999	151		
		Total	1,670

The median cost of these buses was $1,412.45.

Color of Buses

It is necessary that the school bus be readily recognized under all conditions of traffic to guarantee safety to the children. Orange color has been widely accepted for school buses. The National Education Association (515) reported in its *Research Bulletin* that the medium chrome color with black trim is the combination which has the most widespread use.

Entrance

Formerly school buses had the entrance door in the rear. As a safety precaution, the entrance has now been moved to the front of the bus body where it is under the direct observation of the driver. Evans (511) reported that one door near the front operated by the driver has become almost universal practice. More than one-fourth of the states have regulations (515) which require the service door to be located opposite the driver on the right side of the bus and exclusively under the control of the driver.

Make of School Bus

Johns (512), after making his study in Florida, stated that the commonest make of school bus chassis is the Ford. Noble (517), in his study of school transportation in North Carolina, devised a procedure by which various makes of school buses might be rated on the basis of unit costs as they are related to a road score, a load score, an age score, and a carrying capacity score. Ten different makes were listed and ranked on the basis of these four scores and on the basis of a composite score.

Minimum Standards

A few standards relating to school bus equipment are included in the statutes of most states. Such standards relate to stop signs which are to

be painted on the bus, safety glass, brakes, and a few other essentials for safety.

Some states provide more extensive regulations controlling the construction of the school bus, but generally such regulations are not included in the statutes and are issued by the state departments of education. Authorization to establish such regulations is included in the statutes, as in the case of California (523) where the laws indicate that the state department of education shall have the power to adopt reasonable regulations relating to the construction, type, operation, equipment, and color of school buses. It is desirable for the regulations relating to school bus equipment not to be included in the statutes (515) but to be issued by the state departments of education. Revision of the standards is more easily accomplished under this plan.

The National Education Association (515) and the National Safety Council (516) have carefully selected desirable standards for school bus equipment and have presented them in their publications.

Mounting the Bus Body

The National Education Association (515) recommended that the school bus body be mounted on a chassis which will permit approximately two-thirds of the length of the body to be in front of the rear axle. To yield this proportion it should not be necessary to cut the frame and extend the wheel base. Several states prohibit the use of any school bus which has had the frame cut for an extension (515).

Power

The engineering departments of chassis manufacturers issue ratings for all chassis indicating the capacity of the vehicle in terms of the gross weight which can be transported. These gross ratings should be carefully observed when purchasing a school bus. The National Education Association (515) stated in its *Research Bulletin* that the power of the school bus should be adequate to care for the gross weight of the vehicle when traveling the poorest and most hilly roads of the route.

School Bus Seating

Formerly, school buses were equipped with lengthwise seats. At first, when the buses were very narrow, one long seat was installed on the side of the school bus. Later, when buses were made wider, a second longitudinal seat was placed along the center line. Since buses have reached the ninety-six-inch width, it has become customary to install forward-facing seats. Evans (511), in his study in California, found that forward-facing seats predominate in high-school buses where trips are longer, while elementary schools favor lengthwise or combination plans.

Three manufacturers (Superior, Union City, and Wayne) who supply a large portion of the bodies used in the Middlewest have indicated that

95 percent of the buses manufactured during 1936 and 1937 have had forward-facing seats.

In Ohio (518) the transportation study found that of 6,834 buses used during the 1936-37 school year, 41 percent had no forward-facing seats and 23 percent had all forward-facing seats. Thirty-six percent were combinations.

Evans (511) found that more than 92 percent of the buses used in California have upholstery and spring cushions.

Size of the School Bus

Much research is available which indicates that the buses now in use are larger than those formerly used. Evans (511) found that the variation in the length of the bus body resembled closely the normal frequency distribution with a central tendency at seventeen feet. The average load carried was 29.5 pupils and the average seating capacity 32.5.

A study reported in the magazine, *Bus Transportation* (515: 210-11), indicated that during 1935 the manufacturers produced buses as follows:

	Pupil capacity	Number manufactured
Small	Under 40	250
Medium	40–60	8,100
Large	Over 60	1,180

The same magazine reported in the January 1938 issue that 3,225,361 children were carried daily on the 84,061 school buses in use during the 1936-37 school year. These facts indicate 38.4 as the average number of pupils per vehicle. For the United States the medium size bus carrying 40 to 59 pupils has become the most popular type, taking the lead in 1930 and accounting in 1935 for 86 percent of all school bus construction (515). Belknap (509) found an average of 29 pupils per vehicle in his study of the pupil transportation service for New York for 1932-33.

The capacities of the 6,834 buses included in the 1936-37 bus transportation study in Ohio (518) were as follows:

Capacities of School Buses Used in Ohio

Bus capacity	Number of buses	Bus capacity	Number of buses
60–up	314	25–29	365
55–59	264	20–24	305
50–54	554	15–19	154
45–49	871	10–14	152
40–44	1,066	5– 9	1,089
35–39	949	0– 4	58
30–34	693		
		Total	6,834

Williams (524) found the median number of pupils per route for the horse drawn equipment in Iowa to be 13, and for the motor driven equipment the median was 20 pupils.

Unsafe Equipment

Many states have arranged for inspections of school bus equipment to guarantee the elimination of unsafe school buses. In the first inspection of the bus equipment in Ohio (519) conducted in 1935 by the State Highway Patrol, 863 of the 5,112 buses inspected were designated as unsafe.

Needed Research

A number of other characteristics of school bus construction and equipment are of interest to school authorities, but have not been studied in detail, and no research from the point of view of pupil transportation is available. More evidence relating to brakes, governors, capacities, grab handles, fire extinguishers, first aid kits, tires, ventilation, emergency exit, lettering, and maintenance is essential to indicate an optimum condition to be attained by those responsible for the transportation of pupils. Some of these items have been carefully studied by chassis and body manufacturers, but their status and function in relation to school transportation need additional consideration for the guidance of the school authorities.

Other Studies on Cost

In addition to those studies cited, a number of valuable contributions relating to pupil transportation have been made during the last few years (510, 513, 514, 516, 520, 522). These studies were chiefly concerned with costs of pupil transportation and make few references to equipment. Unit costs calculated for various types of equipment and for various policies of management in the control of this equipment make it desirable to list them here as related to research on equipment.

Summary and Conclusions

Studies which touch upon school bus equipment have been largely concerned with the determination of the present status. They reveal the number of pupils transported per bus, the number of buses equipped with fire extinguishers, the number of all metal bus bodies, and similar information regarding the program existing in any area. These studies do not, however, indicate what is a desirable condition with regard to any characteristic of school bus equipment. It seems essential to approach the study of transportation equipment so as to reveal the characteristics which will provide safer, more comfortable, more efficient, and more economical transportation service. This type of information will be most useful to those in charge of the school bus system.

CHAPTER X

State Studies of Local School Units as Related to the School Plant[1]

EDGAR L. MORPHET

THIS ISSUE of the *Review of Educational Research* is the first one which has carried a chapter devoted to studies of school units and buildings made by state departments of education. This is significant in that it indicates a distinctive trend. The need for such studies has existed for many years, but the demands during recent years have been such that many states have decided the time has come to face basic school problems, and have taken steps accordingly.

Related Reviews

The issue of the *Review of Educational Research* devoted to "The School Plant" (548) in the preceding cycle contained a few references to the present subject. The October 1937 *Review of Educational Research* devoted to "School Organization" (557) contained a number of references on the general topic of local school units. These references, which were treated from the point of view of the effect of district and school reorganization on the school program, indicated that the elimination of smaller districts makes possible a more satisfactory program on a more economical basis. For example, the study by Thompson (561) proposed a plan which would eliminate twenty-seven one-room schools in one county, at a saving of $22,497. None of the studies cited in the October 1937 issue of the *Review*, however, was made by a state itself.

There have been several studies of states within the past two decades, usually made by organizations or groups of specialists, sometimes under legislative mandate, and at other times on the request of state or other educational agencies. The present chapter, however, is restricted to those studies which have been carried on by, or under the supervision or sponsorship of, state departments of education.

Alabama

Among the earliest state studies which were objective rather than subjective in nature and which involved some of the newer technics and procedures were those in Alabama and Arkansas, two southern states with entirely different types of administrative units.

Alabama, with the county as the basic unit and with cities of 2,500 or more population the only independent units of school administration, should, theoretically, have had an organization in which the size of administrative units did not materially interfere with the development of

[1] Bibliography for this chapter begins on page 486.

adequate school plants. Starting in 1927 with the Elmore County Survey (526), the Alabama State Department of Education, with the cooperation of the Division of Field Studies of the University of Alabama, and, from time to time, of representatives from other state supported institutions, has completed to date surveys in fifty-seven of the sixty-seven counties in the state, as well as in a number of cities. The only counties in the state in which state department surveys have not been made are Jefferson, Montgomery, Mobile, Lowndes, Hale, Greene, Dallas, Bullock, Lee, and Russell (525).

The Alabama studies, which have probably been the most comprehensive studies of this type made on a statewide basis (with the exception of some of the local school units project studies made during recent years), have brought out rather clearly the following points:

1. Large units (such as the county) do not necessarily insure either properly located school centers or adequate plants. Some of the problems and difficulties encountered are:
   a. Small and expensive high-school centers in places not well suited for high-school locations grew up in spite of the county organization largely because rival communities were ambitious and county boards acceded to their wishes.
   b. Attempts on the part of school officials to foster work in small schools and indifference to the trend toward the establishment of definite centers led to construction of classrooms that were soon abandoned. Sufficient vacant classrooms scattered among small schools were found in Limestone County to supply the school plant needs for a number of years—but they were located where they could not be used.
   c. Lack of any definite county policy, or perhaps an erroneous policy, on the part of the county superintendent and county board resulted in developing small one- and two-teacher school plants in various parts of the county as definitely as if the district organization had prevailed.
   d. The development of adequate school plants in some counties was impossible largely because of poor financial management during prior years and the consequent heavy financial obligations that had to be met.
   e. Administrative indifference or inefficiency resulted in small and inadequate plants in some of the counties.
   f. The plan of state aid, which allotted a given amount of money per county (under certain conditions) made it possible for counties to construct buildings somewhat freely. As a result, some counties had vacant classrooms, other counties had an excessive burden of transportation because of improper location, and still other counties had high schools which never should have existed. (After such findings the plan for state aid for capital outlay was put upon an equalization basis, with the requirement that buildings be located on the basis of studies rather than on the basis of community pressure) (551).
   g. A number of the poorer counties could not have adequate school plants because of defects and limitations in the state equalization plan. (Changes made in the equalization law in 1935 have helped to overcome these difficulties.)
2. District boundary lines, even though the unit be as large as a county or a city, do not make natural boundaries for attendance areas or local school administrative units. The Marion and Winston County studies brought out an instance of children being transported from one county, past a town high school in the edge of the adjoining county, then back into the original county and for an additional distance of five miles to a high school. The Calhoun and Tuscaloosa County studies brought out instances of rural children being transported through sizeable cities to other centers where high schools under the county board were established. The

Houston and Lauderdale County studies pointed to inadequate rural school plants located just beyond city boundary lines. (As a result of these findings laws were changed so as to encourage boards to arrange for children to attend the most convenient and desirably located school, whether that be in the city or in another county.)

3. Tax district lines may be barriers that help to prevent proper development of school centers. Although the tax district in Alabama is not an administrative unit, and exists largely because of a constitutional provision which limits the countywide millage levy, a number of small schools have grown up within the boundaries of tax districts and have continued because of the law requiring the consent of trustees for the elimination of a school.

As a result of the fact that most of the administrative units which existed in the state were of a reasonably adequate size, the Alabama studies gave comparatively little attention to the problem of reorganization of administrative units and devoted much more attention to the proper location of school centers and to working provisions to meet such problems.

Arkansas

In Arkansas the studies were begun about the same time as those in Alabama. The situation in that state, however, was entirely different. In Arkansas the school district has been the basic unit for school administration, and the county has had relatively little authority or supervision over the district. It would be expected, therefore, that one of the main points of attention in the Arkansas studies would be the matter of reorganizing school districts. Whether school centers were small or large or whether they were properly located did not, in Arkansas, depend so much upon other factors as upon the size of the district. If the district was small, the school plant was likely to be small and inadequate; and when the studies were started in Arkansas, most of the districts were comparatively small. In 1927-28 there were 4,170 districts in the state. Partly as the result of a law passed in 1927 giving discretionary power to county boards of education to consolidate school districts when petitioned to do so by a majority of the qualified electors residing in the territory (540), but probably more largely as a result of surveys in 75 counties (529, 537, 538, 539) undertaken through the division of research and surveys of the state department of education, rapid progress was made within the next two or three years in reducing the number of districts. More than 1,000 small districts were eliminated. Owing to a number of factors, however, progress in this direction practically stopped for several years, and in 1934-35 there were still 3,134 districts. Forty-three of these districts had no schools, and 2,351 offered facilities only for elementary pupils; 1,630 of the districts had 50 pupils or less (528).

Missouri

Based on an act of the Missouri Legislature of 1931, which required a Redistricting Board by 1932 to formulate plans for enlarging and consolidating districts within the county, the state department of education of

Missouri set up a division of surveys leading to plans for enlarging districts in 107 counties of the state (550). The surveys, each of which consisted of a twenty-four-page bulletin, were prepared for use by the redistricting boards. In the introduction, the staff stated: "We believe that the schools of the several counties should be reorganized on a basis so that it will be possible to provide standard educational advantages for all the children. . . . The survey staff has no hesitation whatever in recommending larger and better buildings and consolidation wherever possible. Among the many reasons for larger schools than we now have, the following have been found to hold in many sections of the country: . . . Larger buildings are proportionately more economical to construct and maintain than one- or two-teacher school buildings. . . . We believe a school district, in order to maintain an efficient senior high-school unit, should have at least 500 pupils in the twelve grades of work." The maps which accompany the reports for the individual counties bring out the many instances in which school plants could not possibly be enlarged in the existing small districts. Reorganization of districts was thus planned to make possible more adequate school plant facilities in the various counties of the state.

West Virginia

West Virginia followed a different procedure in an attempt to solve its problems of inadequate school facilities which existed largely on account of the district system. By law (enacted in 1933) all districts within counties were abolished, and the county was made the unit. Regarding this, Hyde (543) stated:

> The county unit law in West Virginia abolishing 54 independent and 344 magisterial school districts is the most complete of all such bills enacted by the various states in the Union. In order to make the county school district an effective organization, a plan of consolidation developed for each county had to be made. The importance of having objective information regarding the logical community centers to be fostered and the size of new buildings and additions needed was further enhanced by the legal requirement that school building plans and locations must be approved by the state superintendent of schools.

West Virginia thus set up the county as the administrative unit, and then set about to carry on studies to determine the most desirable location for school centers. Some surveys had been carried on prior to that time (536). A comprehensive program sponsored by the state department following the enactment of the law (532) showed clearly that many of the high schools of the state had been poorly located while the district system was in force; that some of the rich districts had too many high schools while many of the poor districts had none.

Texas

In Texas a series of studies in various counties of the state was carried on beginning in about 1932 and extending over a period of two years (560).

In Texas, as in other states having a number of small districts, the studies showed clearly the handicap to the plant and to other parts of the program because of small districts and made recommendations for more adequate district organization.

Impetus Provided by Special Studies

Beginning in 1934, a sequence of events gave impetus to state and other studies of local school units. The first of these was the publication of Dawson's thorough study (540) of the problem which presented the characteristics of satisfactory schools and administrative units, showed how progress was handicapped by unsatisfactory units, evaluated the results of some of the reorganizations already effected, and presented somewhat in detail procedures for carrying on studies and developing plans for reorganization. Dawson concluded that if adequate school plants, as well as satisfactory administrative and supervisory services, are provided, local school administrative units should have at least 1,600 pupils and 45 teaching units.

> One of the chief results to be expected from the reorganization of local administrative units is the more efficient and economical use of school funds . . . the larger administrative units have larger schools . . . the larger administrative unit facilitates the reorganization of schools. Under the large unit, the matter of reorganizing and consolidating schools is usually left to the discretion of the schoolboard, while under small units, reorganization and consolidation can take place only through the tedious and cumbersome methods of elections and petitions.

Early in 1935 the United States Commissioner of Education called a conference of representatives from a number of states to consider the problem of reorganization of local school units. The results of this conference were published as a bulletin of the Office of Education (533). This publication represented a further attempt to develop principles, procedures, and criteria for the organization of satisfactory local school units and for the evaluation of the results of such organization. The provision of more adequate school plants was considered as one outcome that, in many states, must await the organization of more satisfactory administrative units.

About this time, also, a number of special studies were completed. Among these was the study by Briscoe (530), which showed the relationship between the size of the unit of administration for public schools and the economical administration and supervision of the schools. He concluded that the local school administrative unit should not have less than forty teachers. Cressman (535) attempted to compare school systems by comparing counties in Pennsylvania and Maryland, Pennsylvania having the township and Maryland having counties as units for administration. The effect on the school plant program was noted. Little (549) studied the schools of 223 counties to determine the effect of costs on reorganized school attendance areas through consolidation and indicated possible saving. Tink (562) studied certain phases of county educational organi-

zation with particular reference to the relationship of the taxing district to the principle of equal educational opportunities, which, of course, included the effect on the school plant program. The United States Office of Education (534, 541) also assembled and published considerable material bearing on the problem.

About the time of the conference mentioned above, the Office of Education prepared for distribution a *Handbook of Suggested Procedures for the Reorganization of Local School Units and the Projection of School Building Programs* (564). This handbook gave specific directions for those interested in making a survey of local school administrative units. Later that year the handbook was revised and considerably enlarged (563).

Local School Units Project

This revised handbook was particularly timely, as an application for a project involving the study of local school organization and administration in thirty-two states was published by the Office of Education in 1935. The project was approved, funds being available for only ten states. Work was begun on the project in Arizona, Arkansas, California, Illinois, Kentucky, North Carolina, Ohio, Oklahoma, Pennsylvania, and Tennessee, early in 1936. While the project was directed by the Office of Education, a survey staff in each state was responsible for the local study.

Ohio

Ohio was probably in better position than most of the other states to take full advantage of all of the possibilities. The state School Foundation Program Act, passed in 1935, required each county board to submit during designated years a plan for the reorganization of districts within the county. Following the passage of the act, the state department assisted various county boards in developing plans, and was therefore active in this work at the time of the statewide study (553).

In setting up standards for various phases of the program in Ohio the staff proposed that, according to the state law, there should be an average daily attendance of at least 180 pupils, or an enrolment of at least 200 pupils, in each elementary or high school. A school center of this size would thus be large enough to make possible a fairly adequate school plant and program. The state report pointed out:

> The trend in Ohio, as shown in the preceding discussion, is toward fewer and larger school districts. . . . Larger school districts have larger schools. The per pupil costs in these are lower and the educational offering more satisfactory.
>
> . . . Provision should be made in the recommended county program for the maximum use of the existing school buildings which are satisfactory for school use, and, where new buildings or additions are needed, specific recommendations should be made regarding them together with locations and cost estimates.

This report pointed out the fact that the number of districts decreased from 2,538 in 1920 to 1,729 in 1936. There were in 1936, however, 23 districts with no school, 128 with only one one-teacher school, and 92 with

only one two-teacher school. In 1929-30 there were 144 first-class, four-year high schools with less than 50 pupils enrolled. This number had been decreased to 49 by 1936-37. The fact that a number of good buildings had been built at centers which were not well suited, particularly for high-school purposes, brought about a problem of what to do with some of the existing structures.

In addition to the state project report, which summarized the recommendations and gave extracts from some of the typical studies, a separate mimeographed report of 100 pages was prepared for each of the 88 counties in the state. Reference is here made to the report for Lawrence County which is fairly typical of these studies (554). These reports presented definite recommendations for improving the program, including the school building situation, and should result in helping to bring about a well-planned reduction in the number of units during the next few years.

Arkansas

The local school units project in Arkansas (528) took the nature of a restudy in a number of counties in which Dawson and others had carried on studies some ten years previously. Although the Arkansas study was somewhat handicapped by limited records and reports available under the existing district system, some very significant materials were available. The staff found, for example, that only 800 buildings for whites were suitable for permanent use, while 2,042 were suitable for temporary use, and 879 were unsuitable for further use. Several of the buildings which were considered good were found to be poorly located, largely on account of the district system that prevailed, and it was found that many buildings, particularly in the smaller districts, had been improperly maintained. The staff recommended that the 3,134 districts in existence at the time of the study be reduced to 284.

North Carolina

The local school units staff in North Carolina (552) found a situation in marked contrast to that in Arkansas. Due partly to the fact that many of the units in North Carolina have been organized for a number of years on a county basis and that the only independent or semi-independent units are in cities, school consolidation among the white schools had made rapid progress. District boundary lines have not afforded any material handicap in most sections of the state to the proper location of buildings or to the development of adequate school buildings. The study found only 19 out of a total of 167 administrative units in the state which had less than 40 teachers. At the time of the study there were 100 county units and 67 city units; all the units having less than 40 teachers were small city units. The study reported detailed data on school plant adequacy in the various units of the state. In addition to the state summary, studies were included for three typical counties.

Considerable attention was devoted in the study to the need for further consolidation of Negro schools, which would make possible the construction of larger and more adequate buildings. Attention was called to the fact that this work need not wait on district reorganization in most cases.

Tennessee

The *Report of the Tennessee Educational Commission* (558) stated: "As the state is vitally interested in the school program, it should furnish assistance for the making of efficient building studies, set up plans for buildings, grounds, and equipment, and, as far as possible, provide financial assistance in the construction of necessary buildings. Too much emphasis cannot be placed upon the need for standards for school plants. . . . The state board of education should be empowered to formulate standards for school buildings, grounds, and equipment, and should be authorized to enforce these standards in all building programs." The state department did undertake studies in several counties. The local school units project (559) enabled the state department staff to complete maps for all counties and to carry on further studies of the relationship of school buildings to various phases of the program. While most of the administrative units in Tennessee were organized on a county basis there were 41 special districts provided by legislative enactment and 38 city districts. All 41 of the special districts had less than 1,000 pupils. Twenty-three of the 38 city districts had enrolments of less than 1,500, while only 4 of the counties had less than that number. This situation led the staff to conclude:

> If the special school districts did not exist, the county boards would have less difficulty in building a consolidated school at the population center and providing service to the outlying sections by operating busses. This would make possible satisfactory school facilities for those on the outside of the special districts. . . . Needless duplication of expense and effort could be eliminated as the special districts were abolished. . . . While there are many other obstacles in the way of school consolidation, the existence of the small special administrative units is one of the causes for several counties still operating many one- and two-teacher elementary schools. . . . Experience has proved the county to be the most generally satisfactory unit for local school administration, although no great criticism can be made of the large city administrative unit.

Pennsylvania

Since late in the preceding century, Pennsylvania has been struggling with the problem of providing adequate school plants, and has found that the enlargement of districts in many places is necessary before that can be done. While provision was made for consolidation of districts, new districts created outnumbered the consolidations until 1931. The staff, after studying the situation, pointed to the need for further changes in laws to facilitate changes in district organization. They observed: "Naturally, certain communities will continue to grow and others to decline. It is important that any county planning committee recognize such facts—economic

and social—that will affect the projected building program." The Pennsylvania study (556), in addition to presenting a state summary, included a detailed study of Cameron County as one of the representative studies.

Kentucky

In Kentucky the *Report of the Kentucky Educational Commission* (546) pointed out: "A careful analysis of the conditions of Kentucky school buildings revealed the need for some form of state supervision over schoolhouse planning and construction. . . . As an approach to the problem of determining the status of the school plant in Kentucky, it is necessary to consider the number of types of school districts in the state and the school census and enrolment by the types of districts." On the basis of laws enacted as an outgrowth of the recommendations of this committee, the state department in Kentucky was, at the time the local school units project study was started, in fairly good position to carry on the study and achieve many practical results. Before the 1934 revision in laws a number of small independent school districts had existed in unincorporated places. These, however, were eliminated, and by the time the local school units study was made, the only kinds of school districts were county districts and independent city districts. Of the 120 county districts in 1937, 28 were single administrative units. Only two of the county districts had less than 1,000 children in enrolment, and 10 had less than 1,500. Of the 161 independent districts, 139 had less than 1,000 children and 158 had less than 1,500. The project study in Kentucky (547) found it desirable to recommend the elimination of many of these smaller districts in order to make possible the development of an adequate school program.

California

The California project staff (531) decided, because of time limits and monetary restrictions, to confine attention to the one factor of district organization. It concluded:

> District organization is basic to all other factors affecting public education. As the present study has progressed, staff members have concluded that if this one factor is examined critically and if proposals are submitted which will tend to correct some weaknesses in the program of public instruction in this state which are due to this factor, other factors may be considered at a later time in better perspective and probably with a better chance for fruitful outcome.

Some of the other significant conclusions of the staff are given below:

> It will be necessary to maintain a considerable number of one-room and other small schools in California under the proposals of this study, but there is no good reason why each of these small schools should be administered separately. . . .
>
> The physical condition of existing school plants has influenced the staff in making its proposals. Local attendance areas have been grouped around substantial recently constructed buildings if other factors would permit. . . . Capital outlay expenditures called for in the proposals of this study are considerably lower than those estimated as needed by the *Survey of School Building Adequacy in California in 1934* chiefly because

small, inadequate buildings have not been recommended for retention, thus eliminating a multitude of costly repairs, reconstruction, and replacement costs. Existing school plants, under the proposals of the federal study, have been used more efficiently and new buildings recommended are larger and less costly on a classroom unit basis.

Oklahoma

The Oklahoma study (555) found the state still handicapped by small schools and districts, in spite of recommendations that had been made on previous occasions for establishing larger units. The staff found that 93 percent of all units employed ten teachers or less. It concluded that if present districts were reorganized on the basis of the present financial program, a saving of approximately a million and a half dollars could be effected. Forty-two percent of the white children were found to be housed in permanent buildings, 33 percent in temporary buildings, and 23 percent in buildings not suitable for use. The staff found that financial inability to vote bonds in many of the districts was retarding consolidation. Whenever districts are consolidated, the new district is limited by the bonding capacity of each of the old districts. If any one of the old districts has voted the maximum of 5 percent, the new district can vote no bonds. Therefore, many districts that should be combined are not likely to combine on account of the outstanding indebtedness. This will handicap the development of adequate school plants in a number of parts of the state.

Illinois

The state project report for Illinois (545) included data for only a limited number of counties in the state and presented representative county reports for four counties—Adams, Douglas, Hardin, and Winnebago. In spite of the recognized urgent need in Illinois for changes, the project staff confined its attention to a study of status and avoided making any recommendations. The facts seem to show that there is probably not a state in the Union where proper development of the school plant, as well as of other phases of the educational program, is more handicapped by existing small administrative units. Earlier studies by other agencies resulted in specific recommendations for reorganization of local school units (544).

Arizona

While the state project report in Arizona was not published, the mimeographed report (527) pointed to conditions which do not vary materially from conditions in other states. Due to the fact that new districts can still be organized in Arizona under certain conditions, there is always the possibility that a dissatisfied group of people will organize a new district and that other inadequate schools will be added. The staff recommended that 39 administrative units take the place of the 434 units which existed at the time of the study.

Other State Studies

Studies of local school units have been carried on in a number of states not included in the project discussed above. In Washington, for example, a study was carried on in many counties of the state for a period of several years ending in 1936. These studies resulted in definite recommendations for enlarged administrative units which would make possible more adequate school plant facilities. These studies apparently are not available in printed form. At the present time, Idaho is carrying on a study which has been under way for nearly two years. Results of this study have not been printed as yet but should be available in the near future. Studies of a number of counties have also been carried on in Colorado and Wisconsin, although these were carried on primarily as university studies rather than studies directed by the state department of education.

Florida did not begin studies of this nature until the latter part of 1937. The Broward County Study (542) showed clearly the relationship between school districts and the school plant under somewhat unusual conditions. Although school districts in Florida are not administrative units, they nevertheless may exist as a unit for building purposes, since bonds may be issued only against district funds.

Summary

Various state studies of local school units made during recent years show clearly the importance of adequate organization of administrative units for the development of proper school plant facilities. If the administrative units are small, the school plant must necessarily be small and inadequate. Nothing can be done to provide adequate plants in such areas until the school districts are reorganized. On the other hand, if administrative units are adequate, there are far fewer obstacles in the way of providing adequate school plants. The large administrative units do not, however, ipso facto assure provision of desirable school plants. Due to community rivalry, school plants may, even in large units, be improperly located; small plants may be maintained because of tradition or lack of leadership; or unsatisfactory buildings may have to be used because of inadequacies in the financial program.

The numerous studies of local school units which have been made through state departments of education during recent years point to a growing realization of the importance of the problem and indicate the possibility of reasonably rapid progress toward the development of more adequate units in the future. Such steps should stimulate the construction of properly planned school buildings, better suited to house adequately a comprehensive school program.

CHAPTER XI

Trends in School Architecture and Design[1]

HOWARD DWIGHT SMITH

Gradual Changes Observed

THE VOLUME of new school building construction, which had reached its low point about the end of 1932, has not been very great during the past three years, but owing largely to the stimulus of federal financial assistance, the curve of volume has been steadily upward (578). Recent trends in school architecture do not show a great deal of variation from predicted formula. Adaptations to changing educational programs have been gradual, and radical variations from the traditional trends of the past two decades have not been felt, save in the cases of a few notable exceptions, and those quite recently.

In the *Architectural Record* Ittner and others (574) outlined certain general impulses which were influencing design and construction of school buildings. Ittner (573) reiterated these in the *Architectural Forum*. Betelle (568) emphasized the same general impulses and noted influences in the same direction. We find these same urges influencing architectural trends in school building today. Chief among them are: (a) the increasing public demand for public education and for improved housing facilities; (b) necessity for economies in construction; and (c) changing objectives and technics in the educational program. These three urges have influenced school architecture in varying degrees in the past quarter of a century, but it may be observed that the third one of them is influencing presentday trends more than the others.

A Brief Review of Trends

During the generation following the Civil War, public demand for increased educational facilities resulted in the construction of large school buildings which were little more than groups of single-room schools under one roof. These buildings were generally of modest if not always graceful construction, and represented a comparatively simple educational program. The introduction of vocational training into the educational program had some influence upon design, but the advent of activities which required large areas for assembly and recreation found a marked response in school architecture. The gymnasium and the auditorium, used separately or in combination, made a decided change in trends in the first decade of this century.

This change in trend was followed closely by one which was influenced by legal requirements for fireproof construction, multiple exits, large

[1] Bibliography for this chapter begins on page 487.

window areas, and controlled ventilation. These influences were all present when, after the World War, school construction took on large proportions. With certain comparatively fixed requirements, school design, during the decade 1920 to 1930, seemed therefore to become largely a matter of how ingeniously the complication of classroom, laboratory, gymnasium-auditorium, and administration units could be disposed to give maximum operating convenience in its plan and a minimum of unpleasant relationship of window areas in its exterior appearance.

These fixed problems are still with us today in slightly varied form, the variations due principally to the gradual elimination of fixed school equipment in many areas. But other somewhat radical changes in educational objectives and technics introduce new requirements of design which have been reflected in a limited number of buildings, but which will naturally make their influence more generally felt as the stages of experimentation are passed.

The Problem of Exterior Appearance

In school building design, interior plan arrangement is of principal importance, and exterior design should be a matter of secondary consideration. With reasonable exercise of good taste and a bit of ingenuity, a designer who develops a logical and satisfactory plan from any set of building requirements, no matter how simple or how complicated, may be expected to clothe his creature in a pleasing dress.

People, however, all too easily confuse school design with the exterior expression of it. That which is striking, that which is novel, in the appearance of a structure catches the fancy easily, regardless of whether it is a natural result of the specific functions to be performed, or whether it is a purely decorative or sentimental embellishment. The presence of corner windows in buildings ought reasonably to grow out of a requirement for maximum natural light for the room or for particular views of the exterior, and not primarily for the advertising value of its novelty. It is quite as easy to be ill-proportioned in the use of modern materials as in the use of the Greek Doric or the Roman Corinthian column. There is just as much opportunity for error in placing a poorly proportioned plate glass window around the corner of a prefabricated enameled metal house as there is for making a mistake in the size, location, and detail of a rose window in the stone wall of a cathedral. In the frantic effort of some "moderns" to throw off traditional forms because they are not "organically integrated" with presentday conditions, the value of experience in dealing with tried materials and forms has too easily been lost sight of. In the complete elimination of Doric, Ionic, and Corinthian orders because of limitations which they place upon modern buildings, the general principle of an "order or system" of parts and details need not be entirely ignored. The protective value of a projecting member at the top of a wall, for instance, should not forever be disregarded because a now obsolete order of architecture had such a device called a cornice.

While beauty and dignity of architectural design may be to some extent a matter of personal taste and preference, there are nevertheless generally accepted principles underlying the consideration of mass, scale, proportion, simplicity of surfaces and ornament, and harmonious color combinations. Observance of these general principles of good design may be as rightly expected in new modes of expression as in the traditional styles. Consideration of new forms and methods of expression may well be encouraged by school administrators, lay officials, and architects, but with the realization that any form of exterior expression in school design should follow logically from some requirement of the problem in hand, and that radical departure from accepted forms should likewise be justified by some definite objective—even if only for variety in the architecture of the community.

Consideration of Plan

The design of a school plan to house specific educational programs is mainly dependent upon a statement of the program and an appreciation of the objectives of the program by the designer. A common ground of interpretation and understanding must be reached between school administrator and architect. In a study of the planning of elementary-school buildings conducted in 1936, the United States Office of Education (566) emphasized the importance of a careful statement of the school program in any farsighted building program. Fifty-one of the seventy-four cities questioned in the matter answered that they had prepared such a statement before starting a building program. This is evidence of a tendency toward greater and closer cooperation between the school and the architect, and indicates a definite trend in school building design.

The fact that school authorities recognize the necessity of crystallizing their own thinking in these matters is also an indication of the present trend. Normal changes in curriculum naturally result in some changes in building standards, but a clear statement of what is to be accomplished is the plain responsibility of the school administration. Spain (581) indicated that the planning and erection of school buildings "to meet changing needs of the curriculum, the demands of safety, the dictates of good architecture, and the financial resources of the community, offer a challenge to the superintendent of schools and the architect . . . and make a demand upon their resources which few of them are prepared to meet."

There is a definite trend away from the policy of constructing the building and then fitting a program into it. The organization of the country's first junior high school in Columbus, Ohio, for instance, was effected in 1909 and was administered for nearly twenty years in a building designed for elementary purposes with only eighteen uniform sized recitation rooms and no special equipment. Too often have modern working programs been forced into newly constructed buildings designed without full regard for that program. The current architectural press provides numerous data

for consideration in coordinating function and form of educational areas, as for example, the series of Time-Saver Standards, in which data for instruction areas were given in considerable detail (583).

Educational Factors Affecting Trends

In noting educational influences which are affecting school design, it is well to realize that our short perspective prevents us from complete appraisal or accurate prediction concerning the marks which they may leave on the school buildings of tomorrow. We may, however, note some of the influences which have affected the trends in recent years:

1. Both the auditorium and the gymnasium should be convenient for school use and at the same time be fully accessible for community use without opening the rest of the building to the public. This need has materially affected corridor, stair, and entrance door design. A number of architects were using this scheme in isolated cases two decades ago (574, 576, 580), even though one writer (575) recently called it a new step.
2. The use of the large units of school buildings for general community activities may portend the larger use of other school facilities—classrooms, laboratories, etc.—as a means of accommodating the new phases of adult education which are finding their way into school programs.
3. The health clinic as a part of the administration unit of a modern school building, looked upon a decade or more ago as a luxury, if not indeed an encroachment in the field of the medical profession, is now generally recognized as a necessity. There is a definite trend to include also an office and even laboratory space for a psychologist as well as for a doctor or nurse.
4. Rapid rise of the consolidated or centralized school in rural areas and the increased use of the school lunch in city schools have placed increasing importance on the lunch room.
5. Instead of the older manual training room we have the "laboratory of industries." When the manual arts, the household arts, and the commercial arts are interwoven in the school curriculums, large work areas to accommodate various "centers" of activities common to all these so-called arts are required. These activity "centers" are not confined to the departmentalized schools but are finding their places in the elementary schools.
6. With the present stress upon the use of radio in a variety of educational technics, new structures should not be designed without giving consideration to the use of radio in classroom and assembly procedures. Likewise, the use of sound motion pictures has passed sufficiently beyond the experimental stage to demand consideration in school building design; there is at least the minimum requirement of providing conduit and wiring for sound. Television is not being strongly felt in present school building architecture. It would be folly, however, to make any flat statement that it can be ignored.
7. Covered outdoor play space for use in inclement weather has been somewhat emphasized by the "modernistic" type of building where whole sections of the structure are raised up on thin isolated supports. The structural and mechanical problems presented by the elimination of the basement, while not negligible, are not insurmountable. This provision has been a boon to small schools in the middle and northern sections of the country, permitting outdoor mass activities and supervised play in inclement weather.
8. The teaching technic which makes an outdoor sand table, a garden, a pool, and even an animal pen as much a part of teaching equipment as the desk, the chair, and the blackboard, naturally reflects itself in school architecture in prominent

fashion. Since it is desirable that each class group maintains the integrity of its own activities in such areas, the architect is presented with the problem of designing individual rooms which are partly indoors, partly outdoors.

9. The greatest challenge in school design confronting school people and architects alike is the often talked of realignment of the entire public education program. With the educational leaders thinking of the whole process as "training for democratic citizenship," and "learning by doing," with their objectives and programs both as to administrative and teaching technics still in the making, anything may be expected in the design of buildings to house them. Even the necessity of the traditional classroom may shortly be challenged. Engelhardt (570) suggested unlimited pioneering in the field of community education and service on the part of the schools. Davis (569) outlined expanding programs and possibilities for public education.

Influence of New Building Materials

Entirely aside from the changes in design due to a changing school program the availability of new materials and the constant search for economies in construction are causing changes.

1. Perhaps nothing has had such widespread influence upon design and construction in recent years as has glass in one form or another. Not since the general acceptance and development of concrete, plain and reinforced, early in the present century, has a single material shown such possibilities of being "epoch making" (565). The improvement of manufacturing processes has made available a high quality of clear sheet glass at much lower costs than plate glass, making large window surfaces easy to attain, and reducing the necessity for small paned windows. The availability of large sheets of opaque glass in any color has opened almost unlimited fields for its applied decorative use and for many practical purposes. The introduction of glass block as a structural material has suggested radical departures from traditional procedures. The possibility of admitting light through load-bearing enclosing walls offers a wide range of possibilities to the designer. Glass blocks have, however, been greatly propagandized by the manufacturers; their possibilities must be carefully evaluated by school administrators and architects. Expansion and contraction in changing temperatures must be properly cared for to avoid cracking and deterioration either in the area of the blocks or in adjoining masonry construction. Also, under the glare of direct sunlight, even in cold weather, temperature conditions are set up within the enclosed areas which need special consideration by the heating and ventilating engineer. Many examples of the use of glass block are available. Some illustrations show curtains or Venetian blinds completely drawn over the great expanses of glass which have been provided; this suggests further problems which follow such uses of glass.
2. The mechanical complications involved in air conditioning, particularly as concerns humidity, make it still too much of a luxury to be considered for general use in school buildings. Even the simpler forms of temperature control which have been in vogue for twenty years or more leave much to be desired as far as "fool proof" practical results are concerned. Until present gains in the field of heating and ventilating school buildings are consolidated, air conditioning may best be left for special cases—or for future consideration.
3. Buildings of concrete construction and hard plaster walls and ceilings which become harder and more vibrant as they grow older present a problem of acoustics which non-fireproof buildings of soft brick and lime plaster never presented. In new buildings, with careful consideration of design and material, it is possible to use sound absorbing materials, at least in ceilings of rooms and corridors, at little, if any, additional cost over traditional treatments. Both fireproof and non-fireproof

sound absorbing materials are available. Such materials should be applied against solid surfaces such as hard plaster or masonry to prevent "breathing" through the materials, which causes rapid soiling by dust and dirt.

4. The availability of materials for temporary or removable partitions, particularly in the metals or in plywoods, reasonably well-sound deadened, emphasizes the idea suggested by Barrows (567) that "one of the most significant developments in school building today is that interior walls are not supporting walls; in a modern school a wall can easily be torn down between two classrooms, making it into a library or music room if need be." This is true at any rate of the cross walls. This feature of flexibility takes its place beside another—the open-end corridor, using stairs of such construction and in such location as to readily permit expansion or remodeling.
5. There is a rather universal acceptance of some form of linoleum or mastic material for floors of classrooms and laboratories, particularly where fixed equipment has been eliminated. Terrazzo has a wide preference for corridor floors, often with a linoleum center panel, and wood in some form or another seems to hold its own for gymnasium floors.
6. There seems to be a more general reversion to some sort of hard washable surface for corridor and stair wainscots, in spite of higher initial cost over painted plaster.
7. With the continuing tendency to eliminate applied embellishment in school buildings has come the increased use of color for decorative purposes. It has the merit of easy and frequent replacement. An increasing tendency is also noted in school design to permit the use of wall surfaces as laboratories for student projects.
8. The search for economies in construction methods goes on apace, but the centralized control of prices of the basic materials of construction, such as steel, cement, glass, paint, brick, and lumber, prevents much progress in this field. The use of large masonry units, such as concrete blocks, or of prefabricated metal units, offers some possibilities in economy due to reduced labor items at the building. With the current WPA programs in operation, however, where labor costs are shared by the federal government, there is little to be gained in this direction. Some ingenious designers have used the lowly concrete block in its own right and in ways not even suggestive of its substitution for natural stone. The use of cinder concrete block for the interior of gymnasiums and swimming pools has proved not only an economical measure, but an acoustic advantage as well.
9. With improvements in the forms for the construction of concrete floors, they may be left exposed as ceiling, even in important areas, thus eliminating the expense of a suspended ceiling.

The Unusual Case of California

Three things seem to have worked together in California during these past few years to influence school architecture. To progressive educational leadership and a generally high professional standard of school architecture has been added the necessity of coping with earthquakes. Since 1933, the rigors imposed by natural forces have been reflected in building laws and codes which have in turn affected the design and construction. Engineering requirements of minimum weight, low center of gravity, and elimination of projecting features dictated a construction program not unlike the one which faced European constructors after the World War. In the case of the European Continent, however, the limitations were mainly economic and the necessity for simplicity was in large measure born of poverty. It is interesting to compare, for instance, the public

school of Celle, Germany (571), built prior to 1930, and a school in the communist village of Villejuif, near Paris (577), with such structures as the Long Beach Polytechnic High School and the Roosevelt School at Santa Monica, both of which are described and illustrated in the June 1936 *Architectural Forum*. The continental schools are three stories high, the California schools are one and two stories high, but otherwise the four schools appear to have features in common, both as to plan and exterior appearance. Descriptions of the German school, however, abound with such phrases as "economic considerations are evident in the use of a low base at the corridor walls, exposed electric conduit"; "simplicity in classrooms . . . born of necessity." The descriptions of the California schools, while emphasizing simplicity, strike a different note: "to protect their occupants"; "recognition of outdoor life"; "direct expression"; "surplus architectural motifs, . . . considered aesthetically essential . . . are denied the conscientious architect and he must achieve beauty . . . by trimness, simplicity . . . and studied use of color."

In the case of Hollywood High School, classrooms in one block and laboratories in another are ingeniously joined by an entrance unit. In this building, "exterior design . . . attempts to combine conventional fenestration with the requirements of a modern reinforced concrete structure" (572). A happy combination of experimental effort is represented in the Experimental Elementary School at Bell, California, described in the June 1936 *Architectural Record*. In it the experts of the Los Angeles Board of Education, in cooperation with the architects, have combined features of plan and of construction which are new and frankly experimental. In a number of ways, and as a result of several converging circumstances, California is influencing architectural trends perceptibly.

Illustrations

Buildings which show radical departures are naturally looked upon as news, and published examples of the so-called modern types are therefore common. Five fairly recent magazine issues provide a reasonable diversity of examples to indicate the influences and trends alluded to here, both as to plan arrangement and as to exterior appearance. They are: *Architectural Forum* for June 1936; *Architectural Record* for June 1936, April 1937, and May 1938; and *American Architect* for April 1937. Among these examples are found several foreign school buildings of current interest, and also "A Modern Bibliography of School Design," by Sykes (582), filling ten pages in the June 1936 *Architectural Record*.

Conclusions

The design of school buildings in the United States today is in a most interesting state of transition. Observations of present trends and the

expression of hope for the immediate future lead to emphasis on three general principles:

1. In keeping a highly desirable open mind in the mad rush for improvement, or for change, care must be exercised to avoid the snares of propaganda and of passing fads. The Institute for Propaganda Analysis, 132 Morningside Drive, New York City—an agency for the analysis and appraisal of devices intended to form and influence public opinion—and the United States Bureau of Standards and the American Society for the Testing of Materials may be depended upon to help appraise the value of materials which are widely and extravagantly advertised. It is well for both school administrator and architect to exercise a generous amount of sales resistance at many points.
2. Every device which makes for future flexibility should be well considered. Minimum fixed construction is indicated with concentration of utilities, such as water, steam, gas and drainage pipes, electric conduits, and temperature control, at strategic points from which they may be tapped and carried to rooms of changing size and to equipment in changing location. Shire (579) even suggested the desirability of school construction at the present time taking on a very temporary character. Such construction ". . . of one- and two-story buildings, lends itself readily to alterations, and even permits of ready demolition and rebuilding."
3. The design and construction technics of this period of transition should be devised so far as possible to avoid placing the children who are educated in this period at a great environmental disadvantage. The present generation in the schools has every right to full benefit of education reasonably free from excessive educational experimentation and instability of physical surroundings. It is therefore the duty of school administrator and school architect to accomplish change by evolution rather than by revolution and so influence the trend of school architecture and design as to maintain an atmosphere of open-minded stability, where passing fads are recognized as such, and where solid worth is distinguished from the cheap and the tawdry.

CHAPTER XII

Court Decisions in the School Plant Field[1]

M. M. CHAMBERS

ANNUALLY upwards of a hundred decisions of the higher courts are concerned with the public school plant. Among the phases touched are (a) the acquisition and management of school sites; (b) financing the construction of buildings; (c) contracting for buildings, equipment, and supplies; (d) insurance; (e) liability arising from the condition or operation of the plant; and (f) use of the plant for extra-school community purposes.

General Reviews

During the three years now under review the most important research landmark is Punke's comprehensive study (612) of judicial decisions concerning public school property. This work is based on some 900 cases decided by the higher state and federal courts, from approximately the middle of the nineteenth century up to about 1932, with the preponderance of emphasis on the latter half of that period. The notation of the year in which each case was decided enables the discerning reader to observe the trends in the growth of the various branches of the common law involved. Each of the eleven chapters is concluded with a terse summary enumerating the leading principles deduced from the cases exhibited. Recapitulation of the findings is not practicable here, but some of their bearings upon the topics treated in this chapter will be mentioned at appropriate points.

The *Yearbooks of School Law*, annually reviewing the current cases, regularly include decisions concerning the school plant in several chapters which deal respectively with school property, school contracts other than for teaching, the tort liability of school districts, and school district indebtedness. College and university plants are also touched in chapters on public and private higher education. Contributors on topics related to the educational plant during the period now under review have included Brody (586, 587, 588, 589), Chambers (592), Cooke (594), Day (595, 596, 597, 598), Keyworth (603), Lockenour (604, 605, 606, 607), Owen (608, 609, 610), Punke (613, 614), Spencer (616, 617, 618), Tietz (619), and Weltzin (621).

What the School Plant May Include

The early concept of a school plant included no more than meager housing for academic instructional activities, with adjacent unimproved outdoor space for play. How the addition of other facilities in keeping with social and educational progress has been sanctioned by the courts is shown by Punke's citation of decisions from several states holding that as part

[1] Bibliography for this chapter begins on page 488

of their general power to acquire property for school purposes boards of education may provide playgrounds and gymnasiums, either in conjunction with existing school buildings or separate therefrom; central heating plants apart from any building used for instructional purposes; and temporary school buildings (612:59-63). Other cases approving the provision of a stadium and an auditorium with stage have been reported (593). The chief significance of cases such as these is that the judicial definition of school purposes may and does change to fit new conditions. On the subject of teacherages, judicial opinion seems not to be wholly harmonious. Washington (612:62) and North Carolina (621:55) decisions held that a schoolboard cannot construct homes for teachers unless expressly authorized by statute, but a minority of the North Carolina court dissented, believing that the matter should be within the discretion of the board of education.

Acquisition and Management of School Sites

Transfer of title—Local school districts do not own their real estate in the same sense as a private owner. Instead they are in the position of trustee for the discharge of a governmental function, and the ultimate title to their lands is in the state. A 1937 Missouri decision digested by Weltzin (621:53) propounds this principle. Thus when a district's boundaries were enlarged to include a school site and building formerly belonging to another district, the ownership thereof for school purposes automatically passed to the enlarged district.

Liability for purchase price—Schoolboards cannot assume obligations except under statutory authorization, and hence an agreement to purchase a site may generally be rescinded if the board shows that the purchase is ultra vires or beyond its statutory powers. But it may be otherwise if the board uses the land for a considerable time before seeking to avoid the contract. Thus Spencer digested a 1934 Florida case where a board bought land with an option to transfer it back to the seller at the same price at any time before its notes for the purchase money became due, but failed to exercise the option and then later, after using the land for two years, refused to pay on the ground that the transaction had been beyond its powers in the first place. The board was estopped to repudiate its contract after having accepted all the benefits under it (616:59).

Reversion—When a school site is acquired, either by gift or purchase, the deed sometimes recites that the land is to be used for school purposes only, and that the title will revert to the grantor or his heirs whenever such use is discontinued. The courts will not usually allow reversion to take place, however, unless the deed contains an unmistakable clause to that effect; and other evidence of the intention of the parties will not be heard. Thus Tietz (619:54) explained a Texas decision confirming a school district's title to a site on which oil was discovered, where the orginal deed conveyed title in fee simple to the district "forever" and "for school purposes only for colored children," but was silent regarding reversion. Punke (614:

69-70) described two cases, respectively in Tennessee and Arkansas, illustrating the same principle. He also exhibited a Kentucky decision (614:70) sustaining reversion of title to the grantor where the deed recited that the land should be used for school purposes only, and "should the said land ever be used for any other purpose, the title thereto shall at once revert to and be vested in the first party." Spencer (616:58-59) pointed to a 1933 Kentucky case showing that although that state has a statute requiring school trustees to take title in fee simple to all school sites, nevertheless if a board of trustees disregards this instruction and accepts land with a provision for reversion, the provision will be enforced and the grantor will get his title back if the condition stated in the deed takes place. Reversion is not allowed, however, if the grantor is himself a member of the board of trustees; for as a trustee it is his duty to see that any land taken by the district is taken without "strings," and he, as grantor, will not be allowed to take advantage of the neglect of duty which he, as trustee, perpetrated. Weltzin (621:54) described a 1936 Georgia decision holding that the grantor's reversionary right may be sold by him to a third party without being invalidated thereby.

School Plant Financing

Bond issues—Numerous recent cases involving constitutional and statutory limitations on indebtedness, the approval of proposed bond issues by popular election, and other procedural requirements affecting the power to issue bonds for school building purposes were digested and reviewed by Keyworth (603) and Owen (608, 609, 610). The facts are so numerous and varied that a summary within small space limits would be cryptic.

Self-liquidating plans—When the debt limitation prevents borrowing to finance needed school buildings, ingenious schemes are sometimes devised whereby the buildings may be financed by private capital. The prototype, of which there are several variations, is thus: a private non-profit corporation is created to erect the building, financed by selling bonds which are pledges against the building only, and do not obligate the school district. The private corporation holds title to the building until the bonds are retired, whereupon it conveys the building to the school district. It is understood that the school district will rent the building for school purposes at an annual rental sufficient to retire the bonds within a specified number of years. It is at this point that litigation sometimes arises. Spencer (616:56-57) showed that in Indiana a schoolboard's contract to rent a building for twenty-five years created a present indebtedness for the whole amount to be paid thereunder, and the whole transaction was condemned by the court as an indirect evasion of the debt limit; but in Kentucky, where a schoolboard agreed to rent the building for one year only, with option to renew each year for ten years, the transaction was held lawful. In Spencer's words: "The limitation (of indebtedness) is not on the acquisition of buildings, but on the burdening of the taxpayers; and if the property can

be acquired without increasing the burden beyond the fixed limits, neither the spirit nor the letter of the law has been violated." Subsequently other Kentucky decisions have upheld the foregoing plan when the role of the private non-profit corporation was played instead by a city council (608:70) and by a county fiscal court (621:54).

Federal loans and grants—Both Keyworth (603:78-79) and Owen (609: 88) described cases indicating that the courts were generally inclined to stretch a point, rather than to strike down projects for the construction of school buildings with the aid of federal lending agencies. A 1935 Montana case decided that approval of a bond issue for such a project by vote of the taxpayers alone must be taken to mean that the necessity for the building would have been affirmatively voted by a majority of the electors, including non-taxpayers, in the absence of a contrary showing. A 1935 North Carolina decision held that bond issues without a popular vote, under authorization of a temporary statute, were valid and regular, despite the fact that the constitution prohibited any issuance of bonds without a vote of the people. Punke (613:59-60) digested a 1937 Ohio case which clarifies the line between the sphere of state and federal agencies, holding that a board of education could not, after having signed a contract with a builder, later rescind it on the sole ground that it was not approved by the state director of the federal emergency administration of public works. The state's control over the letting of contracts, and the schoolboard's discretion in such matters, remain wholly unimpaired, said the court, and a stipulation in the notice to bidders that all bids must be acceptable to the federal authorities was "an absolute nullity."

Contracts for School Buildings, Equipment, and Supplies

Punke's admirable book included chapters on the general contractual authority of schoolboards relative to property (612:1-40), contracts for buildings (612:118-48), surety bonds of building contractors (612:149-203), and contracts for equipment and supplies (612:204-20). The current cases were discussed each year by Day in his annual contributions to the *Yearbooks of School Law* (595, 596, 597, 598).

The statutes generally require building contracts to be let only after competitive bidding, and make it mandatory for the schoolboard to award the contract to the "lowest responsible bidder" unless substantial cause can be shown for doing otherwise. Often the courts are asked to pass upon the exact meaning of the words used in the statute. Walker (620) summarized several recent cases defining the term "responsible bidder" and the limits of the schoolboard's discretion. A board should not reject the lowest bid without evidence that the bidder lacks responsibility. The board's determination and the reasons therefor should be reduced to permanent record. However, the presumption is that the board acts in good faith, and those asserting the contrary have the burden of proof; and the mere fact

that a contract was not awarded to the lowest bidder does not create a presumption against the regularity of the action.

A schoolboard's authority to contract is always regulated and limited by statute, but a substantial compliance with these limitations is sometimes sufficient, and an absolutely literal conformity will not always be required. Thus a 1935 Ohio decision (597:71) concluded that when a statute authorized a schoolboard to fix the rates of wages to be paid by successful bidders on building contracts, and required these rates to be printed on the bidding blank, there was an adequate compliance when a board printed the wage schedule on a separate page which it bound with the bidding blank and other relevant papers in a folder. Two 1936 cases (597:72) illustrated the rule that a board of education may ratify a contract that has been made in its name by one acting without authority, but that the acts of the board in recognition of the contract will not constitute ratification unless they be done with full knowledge of the facts and of the terms of the contract.

Two 1936 cases (597:74) also exemplify the principle that a building contractor is bound to achieve the result he agrees to produce, regardless of the fact that the specifications in the contract prescribe materials or methods that make it difficult to do so; but that specifications referring to subsurface conditions on the building site are representations upon which the contractor is entitled to rely, and if he encounters conditions at variance with them, he is entitled to recover from the school district the additional cost occasioned thereby.

Taxation of School Property

Public school property is of course generally exempt from taxation, and the question does not frequently arise except with reference to assessments upon abutting property for local improvements such as street paving or water mains, which are technically not taxes. Punke (614:67-68) reported a 1936 Illinois case in which property owned by a public school district but abandoned for school purposes had been leased for 99 years to a commercial lessee. The annual rental of $22,500 from this property, going into the public school funds of the district, was taxable, both as to the leasehold interest and as to the ownership which was retained by the school district. Weltzin (621:56) digested a 1936 South Dakota case to the contrary, where it was held that a dwelling house owned by a school district and rented to produce income was exempt from taxation under a statute exempting property of "municipal corporations."

Insurance

On buildings—Under the general authority to provide and maintain school buildings, boards of education have implied power to purchase insurance and pay the premiums thereon. Such insurance may be purchased from a mutual company, involving an uncertain contingent liability in addition to a fixed premium but not to exceed a definitely specified sum,

and the transaction is held not to constitute unconstitutional lending of public credit to a private corporation (597:72, 614:62-64). Garber (601) analyzed several cases to the foregoing effect, but found some courts intimating that it would be unlawful for a board to enter into a mutual insurance contract in which its contingent liability was unlimited, and one decision actually so holding, but resting in part upon a constitutional prohibition of incurring any indebtedness in any year exceeding the income provided for it for such year. Werner (622) digested cases for several states and concluded that the implied power to purchase fire insurance and make reasonable expenditures for premiums generally embraces mutual insurance, provided the policies do not involve unlimited liability or other prohibited conditions.

Liability insurance—Schoolboards are generally not liable for injuries caused by the negligence of their employees in the performance of their duties, but this rule often leaves an innocent aggrieved party without a remedy, and the growing solicitude for the welfare of school children while being transported on the highways has given rise to a tendency to permit or require schoolboards to carry liability insurance (591). A 1935 West Virginia decision (597:73) held that statutory authority to provide transportation at public expense does not carry power to purchase liability insurance, because schoolboards, being state agencies, are exempt from liability for personal injuries arising from negligence. But a 1936 Tennessee decision (591, 597:72, 600) held that the power to employ bus drivers and to require them to make bond for the faithful performance of their duties carries with it the power to take out liability insurance covering the operation of school buses. Lockenour (606:80-81) reported and criticized another 1936 Tennessee case holding a county school district liable in damages for negligent injury to a pupil in one of its school conveyances, the liability being predicated upon the existence of a valid insurance policy taken out for the protection of the district, and the damages being limited to the amount recovered thereon. In the absence of insurance the county would not have been liable.

Liability Arising Out of the Condition or Operation of the School Plant

In nearly all states public school districts still enjoy practically complete immunity from tort liability, on the theory that they are strictly state agencies and share the sovereign exemption. The outstanding exceptions are California and New York. California has one statute expressly making school districts liable for injury to pupils caused by the negligence of the district or its officers or employees, and another making counties, cities, and school districts liable in damages for any injury resulting from a dangerous or defective condition of their property, previously known to the board or person in authority and allowed to remain unremedied. Cooke (594:63) reported a 1934 California case holding a district liable for

injury to a girl pupil on account of a cement sprinkler-box which had been allowed to remain on the school ground in a dangerous condition for some time. Lockenour (607:68-69) described three 1937 cases showing respectively that a school district was not liable to a girl high-school pupil injured in an ordinary gymnasium exercise, no specific act of negligence being proved; or to a football spectator who was hit by a pop bottle, since such rowdyism could not ordinarily be expected to be foreseen and prevented in advance; and that an action for negligence against a school district will not be heard in court unless the complainant has first presented his claim for damages to the clerk of the district within the time prescribed by statute.

The New York courts do not always deny recovery against a school district in tort cases. Lockenour (606, 607) found that "in this state a board of education may be held liable for acts of negligence committed by its agents or employees in the management of its property," and digested two 1936 cases, in one of which a schoolboard was held liable for the injury sustained by a boy pupil in a game of dodge ball in the gymnasium when he collided with an unprotected brick pilaster, originally guarded by a board covering which had been negligently allowed to become loose and draw away. In the other case the board was not liable for injury to a large awkward boy who fell by reason of the slipping of a mat on an ordinary smooth gymnasium floor (606:79). A pupil was denied recovery for having her fingers pinched in an ordinary classroom door, but a small girl who lost a finger in a metal slide on the school playground was awarded damages because a handrail had become loose, leaving an opening in which a finger could be caught, and the fact was known to the authorities in charge and negligently permitted to remain unremedied (607:71-72). Many other cases from various states were also reported by Lockenour and Cooke, the usual result being against the complainant's claim, often on the ground of governmental immunity; but a 1937 Connecticut case (607: 69-70) is an exception. Here, on an oiled and slippery gymnasium floor, a piece of apparatus included a beam two inches wide, its top about ten inches off the floor and supported by legs. The beam was varnished and slippery. It was used under the supervision of an instructor. A small boy who fell while walking along the beam and sustained injuries was awarded damages on the ground that the condition of the apparatus constituted a nuisance, and that a school district is not immune from the consequences of maintaining a nuisance.

Undoubtedly the tendency in American law is toward modification of the harsh rule of non-liability, under which innocent victims of negligence are often left without recourse.

Community Use of the School Plant

Punke (612) devoted a chapter to a large collection of cases involving non-school uses of school buildings. Statutes specifically authorizing non-

school uses are generally upheld as constitutional. In the absence of statute, use for private commercial purposes is never sanctioned, but nonprofit cultural enterprises are not barred merely because they charge admission fees. Use for religious purposes has been frowned upon by the courts in Connecticut, Kansas, Missouri, and Pennsylvania, but approved in Illinois, Iowa, and Tennessee. Use of public school property by private schools has been judicially disapproved in Illinois, Ohio, and Pennsylvania, but allowed in Vermont and Rhode Island (611, 612:239-50). As late as 1935 the Arkansas supreme court upheld the right of schoolboards to allow teachers to conduct private tuition schools in public school buildings, to piece out the short term within which public school funds had been exhausted (619).

Punke (614:64-67) more recently described a 1936 Texas case approving the operation by schoolboards of cafeterias for pupils and teachers in school buildings, and a 1936 Washington case holding it permissible for a schoolboard to allow an association of students to operate a lunch room in the building, and devote the profits to student activities in connection with the school. Use of a school building for general cultural, recreational, or instructional purposes by a group whose members may all belong to one religious denomination is not to be confused with use of the building for sectarian purposes, said a New York court in 1936, in upholding the right of the Board of Education of the City of New York to allow its buildings to be used by Catholic, Protestant, and Jewish clubs for meetings which included no teaching of religious doctrine: "Rather than inimical to the educational policy of the state, or subversive of legitimate use, it is a wholesome thing to have the school buildings, . . . used for the purposes and by the groups whose exclusion is here sought" (614:66-67). The tendency is to permit wider use of school buildings for general community purposes related to education, in many states exemplified by recent statutes, and in others by liberal judicial decisions.

College and University Plants

Elliott and Chambers (599) summarized nearly a thousand decisions affecting higher educational institutions, from about the year 1800 up to 1936, and devoted separate chapters to institutional real property, the exercise of eminent domain, and the financing of buildings at state institutions without state appropriations for capital outlay. They also included a chapter digesting about one hundred cases involving exemption from property taxes and assessments, and other chapters on exemption from estate and inheritance taxes, and from miscellaneous federal and state taxes. These latter embrace many cases touching plant operation or the purchase and sale of equipment or supplies. Brody (585:126-33) also reported cases dealing with self-liquidating plans of financing state university buildings and digested current cases on many of the foregoing subjects in his annual contributions to the *Yearbooks of School Law*

(586, 587, 588, 589). Recent tax exemption cases were also studied by Lockenour (604), Spencer (617, 618), and Chambers (592).

The plant of non-profit institutions is almost never taxed, but the depression stringency brought numerous new attempts, some successful, to tax such accessories as fraternity houses and real property of the institution not directly used for educational purposes. Property rented out for business uses has been long subject to taxation in some states, but is exempt in others. Self-liquidating plans for the financing of state university buildings with private capital were generally upheld by the courts, and likewise the more recent plans involving loans and grants from the federal government have successfully stood the test of litigation. The acquisition of sites by condemnation (eminent domain) has often been accomplished by state institutions, but, curiously enough, this power is denied to non-profit educational institutions under private control, despite the fact that it has habitually been granted to various profit-seeking private business enterprises such as railroad, telephone, and power and light companies.

CHAPTER XIII

Status of Research in the School Plant Field [1]

T. C. HOLY

IN THE OCTOBER 1935 *Review of Educational Research* devoted to the school plant, Chapter X dealt with needed research in the field of school buildings and equipment (626). Figures showing expenditures for land, buildings, and equipment, and the proportion which those expenditures were of the total cost of public elementary and secondary education in the United States for alternate years, 1920 to 1932, will be found in that chapter. Most of the remaining part of the chapter is devoted to evidence showing the lack of fundamental research commensurate with the importance of the field. There are also listed in that chapter specific problems needing further investigation.

The significance of research upon problems connected with school buildings is likewise emphasized in the Foreword of the 1932 *Review of Educational Research* entitled, "School Buildings, Grounds, Equipment, Apparatus, and Supplies." Quoted from this Foreword, which was prepared by Frank N. Freeman, then chairman of the Editorial Board, is the following statement:

> All these matters (location, planning, arrangement, and construction) may be dealt with by a rule-of-thumb procedure which has grown up by the gradual accretion of tradition based chiefly on judgment, or on very partial or incomplete research. Such practice is not worthy of modern education. It is likely to be both expensive and ineffective. The alternative method is to study the problems by means of the most advanced scientific technics which are available. The revolutionary findings of the New York Commission on Ventilation is but one of a number of examples which indicate the necessity of careful scrutiny of our practices and of penetrating research into all traditional procedure (624).

Since the problems in the school plant field needing further investigation in 1938 are essentially the same problems listed in Chapter X of the 1935 *Review* on the school plant, it is not necessary to repeat them here. Neither does it seem necessary to repeat the evidences of the lack of a broad, well-integrated program of research designed to obtain scientific information bearing on important aspects of the school plant field.

In this connection, attention is directed to the concluding page of Chapter IV of the present review. On that page the authors pointed out certain problems in the important and now highly controversial field of illumination for which satisfactory answers have not been secured. It seems, therefore, that the purposes implied in the title of this chapter can best be served by presenting brief discussions of the relative emphasis on research in the field of education as compared with efforts in industry and those of the federal government in certain of its activities, and of the progress that has

[1] Bibliography for this chapter begins on page 490.

been made since the 1935 *Review* toward the realization of a comprehensive program of research in the school building field.

Before beginning this presentation, it is appropriate to call attention to the interest in school buildings and equipment as shown by the number of publications in the field. For example, the bibliography of the 1932 *Review of Educational Research* in the school plant area had 476 titles, the 1935 number had 715 titles, and in this issue there are 634 references. Such large numbers of publications would indicate a sustained interest in the school plant. Unfortunately, a majority of these publications are either based on opinions or deal with small, isolated areas in this vast field. This condition may be explained by the fact that investigation in a field as extensive and complex as the school plant costs money and requires time and energy. Thus far these essential factors have not been available for any sustained attack on the unsolved problems in this field which annually takes about thirty-seven cents of every dollar spent for public elementary and secondary education in the United States.

Comparative Information on Research in Public Education, Industry, and Certain Activities of the Federal Government

The only basis for a comparison of the emphasis on research in these different agencies is the relative expenditure. Probably a more reliable measure would be the actual value of the results of the research thus carried on in the achievement of the purposes of the sponsoring agency. For obvious reasons, however, such a measure could not be obtained with any degree of accuracy. The monetary basis does have the advantage of being tangible and universally understood.

In a report of a subcommittee of the Problems and Plans Committee of the American Council on Education dealing with a system of scholarships for workers in educational research, made in October 1936, is this statement:

> In 1934 the research laboratories of the American Bell Telephone Company alone employed over four thousand scientists, engineers, and assistants in its laboratories and appropriated fifteen million dollars in this one year for research purposes.[2] A single industrial corporation thus appropriated for research about ten times the entire amount available for this purpose in all the public schools of the nation (630).

On the basis of the foregoing quotation, one concludes that about $1,500,000 are annually spent for research in the public schools of the United States. Effort was made to check this figure with the statistics collected by the United States Office of Education. Unfortunately, no such information is available from their records. Likewise, it is difficult to secure actual figures on expenditures for research in industry.

In the *New York Times* of Sunday, August 9, 1936, there appeared an article entitled, "Expenditures for Research Expand Steadily as Earnings

[2] Slesinger, Donald, and Stephenson, Mary. "Research." *Encyclopedia of the Social Sciences* 13:330-34.

of Corporations Turn Upward." Quoted from that article is this concluding statement:

> The expenditures on research this year by the 2,000 laboratories will run well over $200,000,000 and should register a 10 to 20 percent gain in 1937.

This figure checks rather closely with a statement made by Edward A. Weidlein, president of the American Chemical Society in 1937, and present director of the Mellon Institute of Industrial Research of Pittsburgh. In an address delivered at Princeton University on April 20, 1937, Dr. Weidlein made the following statement:

> The expenditures for industrial research in this country have increased steadily during 1936, and it is expected that the appropriations for 1937 will run over $250,000,000. With corporate earnings rising markedly and with the new tax law favoring legitimate expenditures in increased research, more and more attention is being given to the development of new products and new uses in the industries.[3]

This estimate included not only the cost of operating the industrial research laboratories, but also the amount of money spent by the companies in transforming laboratory results into plant practices. However, the decline in business during the latter part of 1937 was such that an issue of *Industrial and Engineering Chemistry* carried an article by Hamor which contained this statement: "In the United States over $100,000,000 was expended in industrial research during 1937" (625). This estimate, however, included only expenditures for investigations whereas Dr. Weidlein's estimate included also expenditures for putting research findings into plant practices. Therefore the difference in the two figures is not so wide as the amounts would indicate.

Further evidence of the relative emphasis on research in education as compared with other fields of learning is found in an analysis of doctorates awarded by American graduate schools. For the decade ending 1934-35, there were 20,580 doctorates awarded, of which 2,646, or 12.8 percent, were in the field of education (627). However, of a total of 5,797 graduate fellowships controlled by these institutions of higher education and which are generally awarded for research purposes, only 29 were specifically designated for education (629). In other words, education provided 12.8 percent of the doctors' degrees granted during that decade, but received only ½ of 1 percent of the institutional fellowships awarded (630).

The federal government also engaged in extensive research in certain areas. For example, in 1933-34, the United States Department of Agriculture had in its budget $16,529,586 for research (632). This figure does not include the amount spent by the federal government and by the state governments for agricultural experiment stations. According to a report issued by the Office of Experiment Stations, the total income of the stations in 1936 was $16,425,490 (633). In addition to these expenditures for research in the field of agriculture aggregating more than $30,000,000, the Agricultural Adjustment Act of 1938 (631) contained an appropriation

[3] Information contained in a letter from W. A. Hamor, Assistant Director of the Mellon Institute of Industrial Research, June 1, 1938.

of $4,000,000 per year for the establishment of four research centers to find new uses for agricultural products. When these figures are compared with the estimated $1,500,000 for research in the public schools, and the $25,000 for each of the years 1937 and 1938 for library service and research in the United States Office of Education,[4] the relative emphasis is clearly shown.

Assuming that one and one-half million dollars for research in public elementary and secondary schools of the United States is a reasonably accurate figure, the question pertinent to this discussion on the status of research in the school plant field is what proportion of that amount is used for investigations in school buildings and equipment? On the basis of my own knowledge of the field, I think only a small proportion is used for that purpose. Even though the entire amount were used for investigation in the school plant field, it would still be a small amount for a field which annually takes about $700,000,000 of the funds expended for all public elementary and secondary schools in the United States.

Progress toward the Realization of a Broad Program of Research in the School Plant Field

Workers in this field have long been aware of the lack, and therefore the need, of a broad and continued attack on the manifold problems arising in an area so extensive as the school plant. The National Council on Schoolhouse Construction, an organization made up of directors of divisions of schoolhouse planning in nineteen states, and of architects and school building consultants, have for many years pointed out the need for such an undertaking. As evidence of this early recognition, the New York Commission on Ventilation is cited. This commission, first organized in 1913, was in almost continual operation for eighteen years in conducting extensive studies on the problems of heating and ventilation. For the first ten years of its existence it operated as a commission of the state government. A reorganization in the state, however, made a continuance of this arrangement impossible, so it was reorganized and supported by the Milbank Memorial Fund (628). The work of this commission has been published in a series of volumes beginning in 1923. These reports have produced widespread discussion and a number of changes in heating and ventilating requirements.

The best statement of the present status of an organized effort to bring about a continuous attack on the problems in this field is found in the 1937-38 annual report of George F. Zook, president of the American Council on Education. Quoted from that report under the heading of "School Plant Research Council," is the following:

> For some time the workers in the field of school building planning have felt the need for research in this area. In November 1935 an exploratory committee was created by

[4] Information contained in a letter from Bess Goodykoontz, Assistant Commissioner of Education, United States Office of Education, May 23, 1938.

the American Council to study the problem. After careful consideration this committee presented its conclusions, in part, as follows:

> "There is urgent need of research in the field of school building construction, equipment, operation, and maintenance. There is now no continuous, systematic attack on the manifold problems of the school plant, which annually requires more than $700,000,000 of the funds spent for public elementary and secondary education.
>
> "The committee is convinced that a research program along the lines already suggested will bring worthwhile results. If the annual cost of housing the children in the public schools could be reduced even 1 percent, that would amount to an annual saving of $7,000,000.
>
> "Because of the number and character of the problems in the school building field, a research program to be most effective should be adequately financed for at least a five-year period."

The exploratory committee drew up a proposal calling for an appropriation of $61,500 a year for five years for research in this area. In June 1936 the American Council established the School Plant Research Council composed of leaders in school plant planning and certain other persons representing the allied fields of architecture, engineering, and health. Up to the present time it has not been possible to secure a special appropriation with which to carry on this very important work. Nevertheless, the members of the School Plant Research Council are proceeding with plans for their work. For example, they propose to set up a research project to determine scientifically the proper light intensities, direction, and orientation in a typical classroom situation, both for natural and artificial lighting. Drawings of an experimental classroom in which all possible light conditions can be produced for study have been considered. It is estimated that this experimental classroom can be erected at a cost of approximately $5,000 and the work conducted in collaboration with a university faculty and students.

Other research projects which are under consideration include:

(a) The effect of light intensity on reading speed and comprehension.

(b) Pupil-fixture ratio in different schools, climates, sexes, and racial groups.

(c) Practicability of lower cost construction of one-story buildings, taking into account initial, operating, and maintenance costs.

In the early future the School Plant Research Council expects to issue a bulletin setting forth fully the importance and nature of research in this field.

These illustrations of the interests of the School Plant Research Council are cited in order to show the importance and very practical nature of the research program which is contemplated. In the improvement of American education there is scarcely any factor more desirable than the correct planning of the school plant and certainly none more definitely related to public economy (634).

This School Plant Research Council held meetings in Washington on January 28 and 29 and on May 7 and 8, 1938. Considerable time at the first meeting was devoted to a proposal for a study of school lighting which had been prepared by H. W. Schmidt, supervisor of school building service, State Department of Public Instruction, Madison, Wisconsin. A number of other studies on which individual members of the Council were working were also discussed.

At the second meeting, extended discussion was given to the draft of a study on pupil toilet-fixture ratios which had been prepared by Francis R. Scherer, superintendent of school buildings, Rochester, New York. The council expects to carry on this study under the immediate direction of Mr. Scherer through the cooperation of interested persons in the field, using wherever possible NYA students for the actual checking. Any person

willing to cooperate to the extent of having the actual use of toilet fixtures checked in accordance with procedures developed by the council, is asked to communicate with Mr. Scherer.

The possibilities of financial assistance for individual studies under way by council members were also considered. With this School Plant Research Council as one of the standing committees of the American Council on Education, the pressing need now is for financial support. A number of educational problems are being set up for investigation by the council, so a fairly extensive program can be launched as soon as funds are available. In the meantime, the council expects to go forward with the pupil toilet-fixture ratio study and possibly one or two others for which individual members will assume responsibility.

In addition to the organization and promotion of actual research studies in the field, this School Plant Research Council believes that provisions should be made for certain other activities in the field. Some of them are:

1. The collection, interpretation, and dissemination of research studies which have already been made. This involves reviewing hundreds of books and thousands of manuscripts and articles in educational, engineering, architectural, and allied fields.
2. The arrangement of exploratory conferences to consider reorganizing and allocating the research program needed in certain larger areas, such as special requirements for lighting.
3. The operation of a reference service for school systems in technical phases of plant development.
4. The encouragement of competent and mature students to conduct research in the school plant field, thus taking advantage of the vast research resources in colleges and universities.
5. The collection and analysis of existing statutes and other local provisions affecting school plant requirements, and making these available to boards of education and other interested agencies and persons.

Suggestions on any phase of the program outlined here will be greatly appreciated. They should be addressed to the School Plant Research Council, in care of the American Council on Education, 744 Jackson Place, Washington, D. C.

BIBLIOGRAPHY ON THE SCHOOL PLANT AND EQUIPMENT

Chapter I. Operation and Maintenance of the School Plant

1. "About Termites." *Nation's Schools* 20: 64; November 1937.
2. ALEXANDER, J. C. "Group Work-Assignment System Reduces Cleaning Costs." *Buildings and Building Management* 36: 38-39; April 1936.
3. ALEXANDER, J. C. "The Selection, Training, and Supervision of Employees." *Buildings and Building Management* 37: 28-29, 57-62; February 1937.
4. ALLEN, CHARLES. "Reducing Water Losses in a Small High School." *American School Board Journal* 92: 36, 80; May 1936.
5. ALLEN, E. E. "Custodians Picked With Care." *Nation's Schools* 20: 53-55; August 1937.
6. "Ants—How to Rid Your Lawn of Them." *Model Custodian* 5: 6, 13; July 1935.
7. "Application and Maintenance of Water Waxes." *Buildings and Building Management* 36: 24-25, 56-57; February 1936.
8. BAILEY, GEORGE R. "Roofs and Their Maintenance." *Buildings and Building Management* 36: 29-31, 57-58; February 1936.
9. BENBOW, SPENCER D. "How Janitors Get Their Jobs." *American School Board Journal* 95: 31-32, 100; September 1937.
10. BENNETT, RALPH, and MALONEY, T. J. "How Lighting Affects Color in Interiors." *Nation's Schools* 16: 46; July 1935.
11. BENSON, FLOYD. "Waxes—Their Uses and Characteristics." *Catholic School Journal* 37: 152; May 1937.
12. BESWICK, JOHN C. "Teacher Training Course for Custodian-Engineers." *California Schools* 8: 134; May 1937.
13. "Blackboards—Their Care and Maintenance." *Model Custodian* 6: 16-18; August 1936.
14. BUSBY, CALVIN J. "Maintenance of Wood Floors." *Model Custodian* 5: 2-6; August 1935.
15. CALHOUN, J. B. "The County School Mechanic." *Proceedings, 1936.* National Council on Schoolhouse Construction. Nashville: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1936. p. 72-74.
16. CARR, WILLIAM G. "Salaries Paid School Custodial Employees." *American School Board Journal* 90: 18, 50; June 1935.
17. CASEY, J. T. "Waxing Right on Floors." *Nation's Schools* 15: 60, 62; June 1935.
18. CASTERLIN, E. H. "Waterproofing Brick Walls." *School Business Affairs* 2: 3; December 1937.
19. CHRISTIANSON, H. E. "Systematic Janitor Schedules." *Buildings and Building Management* 36: 42; September 1936.
20. CLARK, LEONARD A. "School Building Cleaning and Sanitation." *American School Board Journal* 91: 23-24, 75-76, October; 35, 80, November 1935.
21. "Cleaning Staff Schedule." *School Management* 6: 138; January 1937.
22. CONFERENCE OF PUBLIC SCHOOL CUSTODIANS, JANITORS, AND ENGINEERS. *Proceedings, 1936.* East Lansing, Mich.: Michigan State College, 1936. 61 p. (Mimeo.)
23. "Conservation Through Calking." *Nation's Schools* 20: 60; October 1937.
24. COOK, SAMUEL A. "The Allocation of Janitorial Man-Power to School Buildings." *American School Board Journal* 91: 27-29, 69; August 1935.
25. COX, WILLIAM H. "Alameda High School Laundry Proves a Money-Saver." *Nation's Schools* 15: 52-53; June 1935.
26. CUNLIFF, DONALD D. "Bettering School Maintenance by Accounting." *American School Board Journal* 95: 39-40, 81; August 1937.
27. CUNLIFF, DONALD D. "Long-Term Maintenance of School Plants." *American School Board Journal* 94: 50-51; May 1937.

28. CURRINGTON, W. F. "Spray Floor First to Eliminate Dust." *Nation's Schools* 17: 66; April 1936.
29. DANIELS, FRANC P. "How to Build a Lawn." *Model Custodian* 5: 8-10; April 1936.
30. "Defects in School Plant Blamed for Loss of Time by Teachers for Illness." *Nation's Schools* 21: 66; March 1938.
31. DUEMKE, B. B. "Public School Building Modernization Combining Construction with Instruction." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 231-35.
32. "An Efficient Set-Up for Large-Scale Cleaning." *Buildings and Building Management* 36: 13-15, 49-50; January 1936.
33. "Eliminating Accident Hazards." *Model Custodian* 6: 20; November 1936.
34. ENGELHARDT N. L., and ENGELHARDT, FRED. *Survey Manual for the Business Administration in Public School Systems.* New York: Teachers College, Columbia University, 1936. 156 p.
35. FALK, P. H. "Reducing Heating Costs at Lake Mills." *American School Board Journal* 92: 41-42; June 1936.
36. "Fall Is Time to Start Lawns." *Nation's Schools* 18: 54; July 1936.
37. FISHER, HERBERT A. "Standard-Practice Orders for Service Employees." *Buildings and Building Management* 36: 32-33, 63-64; September 1936.
38. FISHER, HERBERT A. "Standard-Practice System Keeps Employees Alert." *Buildings and Building Management* 36: 21-23, 55-57; August 1936.
39. FLEMING, T. ALFRED. "Self-Inspection of Buildings for Fire Protection." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 137-39.
40. FLIKEID, JENS. "Avoid Use of Water on Varnished Floors." *Nation's Schools* 17: 66; April 1936.
41. FLIKEID, JENS. "Inspection and Rating of Public School Janitorial Service." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 190-204.
42. FLIKEID, JENS. "Results of Water on Wood Floors." *Model Custodian* 5: 10-11; January 1936.
43. FLIKEID, JENS. "School Personnel, Their Selection and Training." *Model Custodian* 4: 11-13; April 1935.
44. FLIKEID, JENS. "Selecting and Rating of Men for Public School Janitorial-Engineering Service." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 261-302.
45. FROMMELT, HORACE A. "The Effect of Fire Hazards on School Insurance Costs." *Catholic School Journal* 36: 58, 10A; February 1936.
46. FROMMELT, HORACE A. "Watersealing a Building." *Catholic School Journal* 35: 244; September 1935.
47. "Getting Rid of Efflorescence." *Nation's Schools* 19: 60; June 1937.
48. GLEASON, J. L. "The Summer Renovation Program." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 148-51.
49. GRABARKIEWICZ, K. P. "The Custodian and His Work Schedule." *Nation's Schools* 16: 51-53; November 1935.
50. GRABARKIEWICZ, K. P. "Modern Heating Means Efficiency." *Model Custodian* 6: 2; December 1936.
51. HALSEY, R. H. F. "Report of Liaison Committee with Illuminating Engineering Society and American Institute of Architects." *Proceedings, 1937.* National Council on Schoolhouse Construction. Nashville: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1937. p. 18-25.
52. "Hazard From Falling Stones." *Nation's Schools* 18: 50; July 1936.
53. HITCH, EARLE V. "Washing and Cleaning for a Military School." *Nation's Schools* 16: 42-44, August 1935.
54. HOOKWAY, RAY. "A Simple Means for Improving Visibility in Schools." *School Management* 6: 281, 294; June 1937.
55. Illuminating Engineering Society and the American Institute of Architects. *American Recommended Practice of School Lighting.* New York: American Standards Association, 1938. 60 p.

56. Illuminating Engineering Society. *Report on Lighting of Public Schools for Board of Education, New York City.* (Photostated.)
57. "Inspection of School Buildings and Grounds." *Model Custodian* 5: 1-2; February 1936.
58. JOHNSON, FREDERIC B. "M intenance and Operation of a University Plant." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 152-54.
59. JOYNER, S. C. "Reducing School Operating Costs." *American School Board Journal* 90: 27-28, 83, May; 31-32, June 1935.
60. KELLY, DANIEL J. "The Custodian and the School Child." *School Management* 6: 207, 222, April; 244, 254, May 1937.
61. LAFERRIERE, JOSEPH N. "Beware the Cricket on the Hearth." *Nation's Schools* 18: 50; August 1936.
62. LAFERRIERE, JOSEPH N. "Modern Warfare on Roaches." *Nation's Schools* 16: 51-53; December 1935.
63. LAFERRIERE, JOSEPH N. "Pied Piper Plays a Modern Tune." *Nation's Schools* 17: 60, 62; April 1936.
64. LAFERRIERE, JOSEPH N. "Routing the Rat." *Nation's Schools* 17: 64, 66; May 1936.
65. LAMB, A. C. "Custodial Work Is Man-Sized Job." *Nation's Schools* 17: 48; March 1936.
66. "Lawn Maintenance." *Model Custodian* 5: 8, 10-11; August 1935.
67. LAMB, A. C. "Going Over the Roof." *Nation's Schools* 20: 47-48; July 1937.
68. "Lawns Better Left Uncovered." *Nation's Schools* 16: 50; November 1935.
69. "Light Losses." *Model Custodian* 6: 18-20; October 1936.
70. LINN, H. H. "Responsibilities of the School Custodial Staff." *School Management* 6: 246; May 1937.
71. LINN, H. H. "Rights and Privileges of the School Custodial Staff." *School Management* 7: 124-25, 135; December 1937.
72. LINN, H. H. "School Accident Prevention." *School Management* 7: 92, 106; November 1937.
73. LINN, H. H. "School Plant Operation." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 245-51.
74. LINN, H. H. "Selecting the New Custodian." *School Management* 6: 280, 284; June 1937.
75. LINN, H. H. "Selecting the School Custodian." *Nation's Schools* 17: 49-50; June 1936.
76. LINN, H. H. "Treatment of Hard Maple Floors in School Buildings." *School Management* 6: 210-11; April 1937.
77. LINN, H. H. "Uniform Dress is Proposed for School Building Service Employees." *School Management* 7: 60; October 1937.
78. LONGSHORE, JAMES HAWORTH. *Floor Research.* Revised. Brazil, Ind.: Continental College of Floor Engineering, 1937. 107 p.
79. LONGSHORE, JAMES HAWORTH. "How to Select Materials for Treatments for Floor Finish." *Model Custodian* 5: 3-6, November; 10-11, December 1935.
80. LONGSHORE, JAMES HAWORTH. "Scientific Floor Maintenance." *School Executive* 57: 251, 284; February 1938.
81. LOUTHAN, QUINTON E. "Saving Money for San Benito Schools." *School Management* 5: 158; February 1936.
82. LUEHRING, FREDERICK W. *Standards for the Swimming Pool in Educational Institutions.* New York: the Author (Columbia University), 1938. (Doctor's thesis, Columbia University, 1938.)
83. MCCULLOUGH, ASHLEY MELVIN. *A Critical Analysis of the Fuel Management Program for Schools.* Contributions to Education, No. 713. New York: Teachers College, Columbia University, 1937. 141 p.
84. MCCULLOUGH, ASHLEY MELVIN. "Facts on Fuel Costs." *Nation's Schools* 18: 54; November 1936.
85. MCCULLOUGH, ASHLEY MELVIN. "Fuel Management." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 190-99.

86. MCCULLOUGH, ASHLEY MELVIN. "Methods of Purchasing Coal in Small Communities." *American School Board Journal* 94: 36, April; 31-32, May 1937.
87. MCCULLOUGH, ASHLEY MELVIN. "Most Heat for the Money." *Nation's Schools* 19: 64, 66, 68; March 1937.
88. MCCULLOUGH, ASHLEY MELVIN. "Put on the Heat!" *School Executive* 56: 149-50; December 1936.
89. MCCUNN, DRUMMOND J. "Pasadena Schools Cut Laundry Costs." *Nation's Schools* 16: 48-50; November 1935.
90. MACRIE, A. F. "Reconditioning Exterior Walls." *School Business Affairs* 2: 2-3; December 1937.
91. MAHONE, LESLIE W. "Fifth Annual Custodian Training School." *School Executive* 56: 481; August 1937.
92. MITCHELL, H. S. "A Playground Surface." *School Business Affairs* 1: 7; March 1936.
93. MITCHELL, H. S. "School Janitress Best at Cleaning Classrooms." *Nation's Schools* 17: 56; February 1936.
94. MITCHELL, H. S. "Using Employees for Building Repairs." *School Business Affairs* 1: 6; August 1936.
95. MOORE, PERRY M. "Waterproofing Problems Need Careful Analysis." *Buildings and Building Management* 36: 42-43, 70-74; April 1936.
96. MUSICK, WILLIAM EARL. "Color in Schoolroom Decoration." *American School Board Journal* 96: 45-46; February 1938.
97. "No Winter Blanket Needed for Lawn." *Nation's Schools* 17: 54; January 1936.
98. "Old Painter's Trick is Still Practical." *School Management* 5: 186; March 1936.
99. "Operation of Buildings and Grounds." *School Business Affairs* 2: 7; December 1937.
100. PEARSON, R. J. "Cooperation." *Model Custodian* 5: 2-3; December 1935.
101. "Personal Appearance." *Model Custodian* 5: 3; February 1936.
102. "Potent Destroyers of Good Turf." *Model Custodian* 5: 11-13; June 1936.
103. PRICE, HERBERT H. "Swimming Pools." *Model Custodian* 5: 16-17; July 1935.
104. "Protecting Paint." *Nation's Schools* 17: 48; April 1936.
105. PYKOSKI, CONRAD. "Inspection and Rating of Public School Engineering Service." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 205-19.
106. PYKOSKI, CONRAD. "New Faces for School Blackboards." *Nation's Schools* 18: 54; October 1936.
107. PYKOSKI, CONRAD. "Service Reports on Light, Power, and Water, and Their Use in the Economical Management of Public Schools." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 220-30.
108. PYKOSKI, CONRAD. "Washing Painted Walls and Ceilings in Public Schools." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 162-65.
109. PYKOSKI, CONRAD. "When It's Wash Day for the Walls." *Nation's Schools* 16: 54-55, 64; November 1935.
110. REAGLE, FRED P. "Better Telephone Service at Lower Cost." *Nation's Schools* 17: 54; January 1936.
111. REGER, CARL, and BRAKE, A. K. "Fire Insurance Engineering Service." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 165-68.
112. "Renovating Established Lawns." *Model Custodian* 4: 5-7; June 1935.
113. "Repairs on a Lean Budget." *Nation's Schools* 21: 50; March 1938.
114. RICHTMIRE, H. A. "Science Proves Value of Washing Painted Walls and Ceilings." *Catholic School Journal* 36: 137-38, 12A; May 1936.
115. ROBERTSON, LESTER B. "Custodians in Uniform." *Nation's Schools* 21: 56; February 1938.
116. ROBERTSON, LESTER B. "Gas for Heating." *Nation's Schools* 20: 59-60; October 1937.
117. SAYLOR, GALEN. "Number of Months Employed and Salaries of School Custodians in Nebraska." *American School Board Journal* 95: 44-45; October 1937.

118. SCHERER, FRANCIS R. "The Utilization and Operation of School Swimming Pools." *Proceedings, 1937.* National Council on Schoolhouse Construction. Nashville, Tenn.: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1937. p. 47-57.
119. SCHULTZ, FRANK G. "Observations on the Use of Bakelite Floor Finishes." *American School Board Journal* 96: 49; March 1938.
120. "Scrubbing by Mechanics." *Nation's Schools* 20: 56; November 1937.
121. SHELDON, BURDETTE R. "The Efficient Operation of a Central Heating System." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 169-71.
122. "Should the General School Cleaning Be Done in the Day Time or at Night?" *School Business Affairs* 1: 10-11; October 1936.
123. SMITH, HOWARD LELAND. "Color as Applied to the Modern School." *Nation's Schools* 15: 53-55; April 1935.
124. "Standardizing Janitorial Service in Alhambra, Calif." *American School Board Journal* 93: 64-66; September 1936.
125. STEVENSON, EDMUND. "Selection and Supervision of School Janitors." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 241-44.
126. "Suggestion to Painters." *Nation's Schools* 16: 58; September 1935.
127. "Summer Excursion." *Nation's Schools* 20: 56; August 1937.
128. "Summer Renovations." *Nation's Schools* 19: 68; May 1937.
129. "Sweeping Classrooms." *Model Custodian* 4: 2-7; April 1935.
130. "Sweeping Stairways." *Model Custodian* 5: 4; February 1936.
131. "Swimming Pool Equipment." *Model Custodian* 6: 9-11; November 1936.
132. "That School Lawn." *Nation's Schools* 20: 68; September 1937.
133. "Thinners." *Model Custodian* 5: 3; December 1935.
134. "Thinning Paint for Various Woods." *Nation's Schools* 17: 52; May 1936.
135. "Timesavers in Dusting." *Nation's Schools* 20: 50; August 1937.
136. TINKER, MILES A. "Illumination Intensities for Reading." *American Journal of Ophthalmology*, November 1935.
137. TOLMIE, HUGH D. "Stokers Economize for Rockford Schools." *American School Board Journal* 95: 34-36, 82; August 1937.
138. TYLER, E. A. "Squeezing Profits from Steam." *Buildings and Building Management* 36: 30-32; November 1936.
139. "Use of Sponge in Washing Walls." *Nation's Schools* 17: 48; February 1936.
140. "Using Paint As Light." *Model Custodian* 5: 15; July 1935.
141. VILES, N. E. "Janitors Go to School." *Nation's Schools* 19: 49-50; February 1937.
142. VILES, N. E. "Training School Janitors and Maintenance Men on a State-Wide Basis." *Proceedings, 1936.* National Council on Schoolhouse Construction. Nashville, Tenn.: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1936. p. 32-36.
143. WALKER, TROY D.; EMERSON, D. A.; and BAIN, V. D. *A Manual on the Construction and Care of School Buildings.* Salem, Ore.: Oregon State Department of Education, 1937. 119 p.
144. WARREN, R. S. "Look to the Starting Point in Your Cleaning Program." *Model Custodian* 6: 15-17; December 1936.
145. "Water Losses." *Model Custodian* 6: 23-24; November 1936.
146. "Waxed Floors Cause Many Accidents." *School Management* 6: 213; April 1937.
147. WELLS, LYAL L. "Evolution of Floor Treatment in Ventura." *American School Board Journal* 93: 32; July 1936.
148. "What Are the Best Methods of Treating and Cleaning Terrazzo Floors?" *School Business Affairs* 1: 10; October 1936.
149. "What Price a Good Custodian?" *Nation's Schools* 18: 50; December 1936.
150. "When Walls Leak." *Nation's Schools* 18: 54; December 1936.
151. WOMRATH, GEORGE F., chairman. "Economic and Efficient Maintenance of the School Plant." *Proceedings, 1934.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1934. p. 239-42.
152. WOMRATH, GEORGE F., and CAMPBELL, H. F. "Janitorial-Engineering Personnel Record for Public Schools." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 238-52.

153. WOMRATH, GEORGE F., and HELM, LESLIE C. "The Minneapolis Janitor-Engineer Training School and Its Purposes, Objectives, Methods of Instruction, Course of Study, Facilities, and Accomplishments." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 166-81.
154. WOOLDRIDGE, C. L. "Comprehensive School Safety." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 158-63.
155. WRIGHT, EMMET Z. "Modern Floor Maintenance." *Model Custodian* 6: 11-15; July 1936.

Chapter II. Equipment, Apparatus, and Supplies

156. ABBET, HENRY B. "Inventory Record and Accounting for Stores Control." *Educational Business Manager and Buyer,* October-November 1937. p. 12.
157. ADAMS, BURTON A. "Substituting New for Old." *Nation's Schools* 17: 44-47; March 1936.
158. ALPERIN, DANIEL M. "Practicing Strict Economy in the Athletic Program." *Nation's Schools* 16: 53-55; October 1935.
159. BAUER, HAROLD C. "Minnesota Goes Audio-Visual." *Nation's Schools* 20: 49-50; August 1937.
160. BEATTY, WILLARD W. "The Schoolroom and Its Equipment." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 327-30.
161. BROWNELL, S. M. "Seven-Point Plan at Grosse Pointe." *Nation's Schools* 21: 44-48; February 1938.
162. BRUNSTETTER, MAX R. "The Audio-Visual Studio." *School Executive* 55: 215-17, 236; February 1936.
163. BRYAN, MARY DEGARMO. "Beauty and Utility in Food Service: The Public School Cafeteria." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 289-98.
164. BURMAHLN, E. F. "Made Modern To Type." *Nation's Schools* 19: 53-54; May 1937.
165. COOK, SAMUEL A., and MARTIN, CECIL F. "Outdoor Areas and Facilities for Physical Education—Their Planning and Maintenance." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 227-32.
166. CORNET, GEORGE A. "Modern Views on Lighting." *Nation's Schools* 19: 53-56; June 1937.
167. COUNCELL, W. M. "System in Handling Supplies." *Nation's Schools* 19: 51-53; April 1937.
168. CRIPPEN, JOHN K. "Adapting Motion Pictures to the School Curriculum." *School Management* 7: 140; December 1937.
169. CURRINGTON, W. F. "School Makes Itself Heard." *Nation's Schools* 17: 49-50; March 1936.
170. CURRY, GLADYS MYRLE. "Points to Consider in Maintaining the Cafeteria." *School Management* 6: 276-77; June 1937.
171. DAVIS, ED. "Trends in Methods, Organization, and Selection of Subject Matter for the General Shop." *Industrial Education Magazine* 39: 25-30; January 1937.
172. DAVISON, LYMAN W. "Lawrence High School." *American School Board Journal* 94: 49-53, 99; February 1937.
173. DECKER, W. N. "The Administration of School Supplies in Small Cities." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 221-23.
174. DEVEREAUX, F. L. "The Audio-Visual Studio." *American Architect and Architecture* 150: 65-70; April 1937.
175. DEVEREAUX, F. L. "Utilizing Educational Talking Pictures in the Schools." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 235-37.
176. EMERSON, EDWARD C. "A New Printing Shop in the Frank V. Thompson School, Dorchester District, Boston." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 419-20.

177. ENGELHARDT, N. L., and UHL, W. L. "Planning Windows for High-School Buildings." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 44-46.
178. ENGELHARDT, N. L., and ENGELHARDT, FRED. *Survey Manual for the Business Administration in Public School Systems.* New York: Teachers College, Columbia University, 1936. 156 p.
179. ERNST, JOSEPH P. "Selection of School Supplies." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 219-20.
180. ESSEX, DON L. "Planning Cafeterias for Multiple Use." *School Executive* 56: 136-37; December 1936.
181. FALGE, FRANCIS M. "Lighting the School Stage." *Nation's Schools* 21: 50-54; January 1938.
182. FARGO, LUCILE F. "School Library Planning and Equipment." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 227-32.
183. FENNER, PHYLISS R. "They Call It Our Library." *Nation's Schools* 20: 53-55; July 1937.
184. FORD, W. S., and WINN, H. P. "Planning the Administrative Suite." *School Executive* 56: 9-10, 34; September 1936.
185. FOULK, W. B. "Issuing Supplies to Undergraduate Laboratories and Auxiliary Service." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 436-47.
186. FRIEND, W. K. "Sound Facts on Noise." *Nation's Schools* 18: 49-50; September 1936.
187. FRYKLUND, VERNE C. "Innovations in Industrial Arts." *Nation's Schools* 20: 33-34; July 1937.
188. FUCHS, THEODORE. "Equipment for School Dramatics." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 267-76.
189. GAISER, SAMUEL. "Efficient School Supply Management." *School Executive* 55: 316-17; April 1936.
190. GAISER, SAMUEL. "Organizing a School System Supply Service Agency." *Nation's Schools* 16: 48-51; September 1935.
191. GIBSON, J. C. "The Business Office Looks at the Band." *School Business Affairs* 3: 3; May 1938.
192. "Grant to the Committee on Motion Pictures in Education." *School and Society* 46: 793-94; December 18, 1937.
193. GRAVES, LULU G. "Doing Right by the Dishes." *Nation's Schools* 18: 55-57; July 1936.
194. GREENE, OUIDA. "Personalized Unit Kitchens." *Forecast* 54: 101-36; March 1938.
195. HAMON, RAY L. "Trends in Types of School Seating." *Nation's Schools* 16: 57-58; September 1935.
196. HANSEN, J. E. "Administration of the Visual Instruction Program in Schools." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 366-69.
197. HANSON, HOWARD. "Music Invades the Public School Curriculum." *Official Report, 1936.* Washington, D. C.: Department of Superintendence, National Education Association, 1936. p. 205-13.
198. HARRISON, W. K., and FOUILHOUX, J. A. "The Design of Classroom Windows." *School Executive* 57: 28-29; September 1937.
199. HARRISON, W. K., and FOUILHOUX, J. A. "Movable Unit-Type Partitions." *School Executive* 56: 393, 411; June 1937.
200. HEMENWAY, H. S. "The Superintendent of Schools Discusses the General Features of Auditorium Planning for the Community School." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 346-47.
201. HENRY, NELSON B., and OTHERS. *Bulletin No. 6.* National Association of Public School Business Officials. Nashville, Tenn.: the Association (Sec.: R. L. Hamon, George Peabody College for Teachers), 1938. p. 67, 68, 72, 73, 83, 85, 86, 88, 91, 93.
202. HENZLIK, F. E. "Taking the School Inventory, and Accounting for School Supplies in Small Schools." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 125-28.

203. HIBBERT, R. W. "The Distribution of Public School Supplies." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 161-64.
204. HIBBERT, R. W. "The Purchase of School Supplies and Equipment." *American School Board Journal* 91: 42-44; September 1935.
205. HIBBERT, R. W. "School-Supplies Management." *American School Board Journal* 91: 28-30, 75; October 1935.
206. HIBBERT, R. W. "What Criteria Should Determine the Selection of Supplies." *School Business Affairs* 2: 7; June 1937.
207. HICKEY, PHILIP J. "The Business Management of the St. Louis Public Schools." *American School Board Journal* 91: 19-21; December 1935.
208. HOEHLE, J. C. "Repair of Physical Training Equipment." *School Business Affairs* 3: 6; May 1938.
209. HOLMES, WALTER J. "Good Lighting and Good Scholarship." *School Executive* 57: 72-73; October 1937.
210. "Homemaking Courses in Lincoln High School, Kansas City, Missouri." *Practical Home Economics* 16: 64-65; February 1938.
211. HONNOLD, F. E. "Laying Suitable School Floors." *School Executive* 57: 130-31; November 1937.
212. HORRALL, A. H. "Development of an Elementary Library." *American School Board Journal* 90: 44, 72; May 1935.
213. HOSKINS, BENA. "Cafeteria With a 1937 Label." *Nation's Schools* 19: 66-72; April 1937.
214. HOSKINS, BENA. "Efficient Equipment Selected for Fort Worth Schools." *School Management* 5: 132; January 1936.
215. HUTCHINSON, J. RAYMOND. "Fundamentals of Visual Education." *School Executive* 55: 186-88; January 1936.
216. "Instructional Materials Furnished Free To Pupils." *School Business Affairs* 3: 2-3; June 1938.
217. JAMES, R. L. "Handling Supplies in a Small City." *School Business Affairs* 1: 2; November 1936.
218. JENNINGS, ROYALSTON F. *General Shop Gas and A.C. Arc Welding and Cutting.* Bloomington, Ill.: McKnight and McKnight, 1937. 82 p.
219. JOPLIN, MISSOURI, BOARD OF EDUCATION. *Monograph on the General Shop for the Joplin High Schools.* Bulletin No. 1. Joplin, Mo.: the Board, 1937. p. 13-20.
220. KNOLL, A. A. "School Cafeteria Management in the Western States." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 175.
221. KORFF, ALFRED M. "One District Solves High School Problem." *Nation's Schools* 18: 40-42; August 1936.
222. LEWIS, JOHN W. "The Organization of the Business Division of Baltimore City Schools." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 61.
223. LLEWELLYN, RALPH C. "The High-School Cafeteria." *American School Board Journal* 94: 47-50; January 1937.
224. LONG, RAYMOND V. "Special Types of Equipment for High-School Science Laboratories." *American School and University, 1936.* New York: American School Publishing Corp., 1938. p. 520-26.
225. LOSO, FOSTER W., and TONNE, HERBERT A. "Equipment of the General Business Training Classroom." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 265-66.
226. LOWDERMILK, R. R. "Modern Educational Applications of Radio-Sound Equipment." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 360-65.
227. LOWDERMILK, R. R. "Right and Wrong of Radio." *Nation's Schools* 18: 51-53; October 1936.
228. LYDEN, CLARA C. "Materials and Equipment for the Younger Children." *Childhood Education* 13: 11-16; September 1936.
229. MARSHALL, JAMES. "The Sound Film in Education." *American School Board Journal* 91: 29-30; July 1935.

230. MARTIN, GILES H. "The Importance of Proper Selection of Equipment for Vocational School Shops." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 566-73.
231. MARTIN, WALTER C. "Efficient Use of Visual Aids and Radio." *School Executive* 55: 332-34, 354; May 1936.
232. MCALLISTER, ADDAMS S. "Federal Standards for School Use." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 181-84.
233. MCKEE, JANE W., and GRAY, LILLIAN. "Playground Equipment." *Childhood Education* 13: 354-57; April 1937.
234. MCLAIN, WALTER, and CONDIT, HERBERT J. "Central Storage in Smaller Cities." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 223.
235. MCNAMARA, EDWARD J. "Office Practice—An Integrated Laboratory Project." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 233-35.
236. MICHIGAN INDUSTRIAL EDUCATION SOCIETY. *General Mechanical Drawing, 1937.* p. 151.
237. MILLER, CHESTER F. "Control and Storage of Supplies." *Nation's Schools* 20: 57-58; December 1937.
238. MILLER, WILLIAM T. "The Map Survey." *American School Board Journal* 91: 22, 74; December 1935.
239. MOE, GUSTAVE A. "Budgeting and Accounting for Local School Districts in New York State." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 200-14.
240. MOEHLMAN, ARTHUR B. "Remodeling—A Study in Contrasts." *Nation's Schools* 18: 44-46; December 1936.
241. MOODY, CHESTER A. "This School Doubles Up." *Nation's Schools* 19: 55-58; March 1937.
242. MORAN, BLANCHE E. "Lunch in a One-Teacher School." *Nation's Schools* 18: 57-60; August 1936.
243. OTEY, C. M. "The Principal's Office—Then and Now." *School Executive* 56: 468-69, 490; August 1937.
244. PALMER, ROY A. "New Light on Lighting." *Nation's Schools* 19: 51-54; February 1937.
245. PARMERTER, ELIJAH. "Humaneness in School Equipment." *School Executive* 56: 349-50; May 1937.
246. PERRY, ARMSTRONG. "Looking Ahead in Radio." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 221-23.
247. PERSELL, GEORGE A. "Utility Typifies Modern School Equipment." *Nation's Schools* 17: 42-46; January 1936.
248. PIERCE, CHARLES E. *Bulletin No. 6.* National Association of Public School Business Officials. Nashville, Tenn.: the Association (Sec.: R. L. Hamon, George Peabody College for Teachers), 1938. p. 11, 28, 45, 50.
249. PIERCE, R. T. "Seeing Things In a New Light." *Nation's Schools* 18: 48-50; July 1936.
250. PRICE, MILDRED E. "Adventures Through Maps." *Childhood Education* 13: 206-10; January 1937.
251. PULVER, HARRY E. "The Athletic Equipment Room." *American School Board Journal* 93: 56-58; October 1936.
252. "Purchasing Supplies." *School Business Affairs* 1: 7; March 1937.
253. RAMSEYER, LLOYD L. "Administering a Visual Aids Program." *American School Board Journal* 96: 18, 91-92; February 1938.
254. RANDALL, DONALD. "Radio System Within Reach of Any School." *Nation's Schools* 16: 55-57; July 1935.
255. "Report of the Committee on Minimum Equipment." *Journal of Chemical Education* 14: 386-92; August 1937.
256. RICDON, VERA E., and SORENSON, FRANK E. "Equipment for Teaching Geography." *School Executive* 55: 330-31, 357; May 1936.

257. ROBERTS, F. G. "New Development in Sound Pictures as an Aid to Education." *Proceedings, 1935.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1935. p. 73-75.

258. ROWLEY, HAROLD H. "Education and the Short Waves." *School Executive* 55: 373, 387; June 1936.

259. SHREVE, JOHN C. "Purchase of School Supplies." *School Executive* 53: 274, 287; May 1935.

260. SMITH, HOWARD LELAND. "Designed to Meet the Children's Needs." *Nation's Schools* 16: 44-47; November 1935.

261. STODDARD, ALEXANDER J. "The Talking Picture in Education." *American School Board Journal* 93: 25-26, 71; July 1936.

262. STODDARD, GEORGE D. "The Planning and Equipping of Nursery Schools." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 218-21.

263. STOCSDILL, J. W. E. "Physics Classroom and Laboratories in the Wichita High Schools." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 344-45.

264. STRACKE, GEORGE A. "Pictures and Public." *Nation's Schools* 30-32; December 1937.

265. STRICKLER, W. E. "The Selection of School Supplies." *Proceedings, 1937.* National Association of Public School Business Officials. Pittsburgh: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1937. p. 215-18.

266. STUDEBAKER, JOHN W. "We Need Visual Aids." *Nation's Schools* 18: 47-49; December 1936.

267. STURROCK, WALTER. "Better Lighting in School Buildings." *School Executive* 55: 97-99, 113; November 1935.

268. STURROCK, WALTER. "Planning Artificial Lighting for School Buildings." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 275-82.

269. SUFFIELD, CHARLES L. "The Administration of Supplies." *School Executive* 55: 15-18; September 1935.

270. SULLIVAN, JOSEPH V. "First Aid for Visual Aids." *Nation's Schools* 18: 53-56; September 1936.

271. SWAIN, FRANCES L. "Home Economics Rooms in a Large City High School." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 466-70.

272. SYKES, EARL F., and WHITE, RAYMOND. *Bulletin No. 6.* National Association of Public School Business Officials. Nashville, Tenn.: the Association (Sec.: R. L. Hamon, George Peabody College for Teachers), 1938. p. 104, 122, 123.

273. SYKES, EARL F. "Difficulties Encountered in Using Specifications and How They May Be Overcome." *School Management* 7: 151; January 1938.

274. SYKES, EARL F. "The Use of Specifications in Purchasing School Supplies and Equipment." *School Management* 7: 122-23; December 1937.

275. THOMAS, R. H. "The School Cafeteria." *School Business Affairs* 1: 6; March 1937.

276. TOOKER, E. POST. "Serviceable Floorings for Schools." *School Executive* 55: 335; May 1936.

277. TYLER, I. KEITH. "Developments in the School Radio-Sound Field." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 356-60.

278. U. S. DEPARTMENT OF THE INTERIOR, OFFICE OF EDUCATION. *Space and Equipment for Homemaking Instruction.* Home Economics Series, No. 18, Bulletin, No. 181. Washington, D. C.: Government Printing Office, 1935. p. 19, 45-58, 93.

279. WALL, JESSIE M. "Cafeteria Organization." *Practical Home Economics* 16: 163-64; April 1938.

280. WEAVER, OLNEY S. "Playground Equipment and Its Use." *School Executive* 55: 338-39; May 1936.

281. WELLER, GERALD M. "Measuring the Efficiency of the Business Management of a School System." *American School Board Journal* 92: 31-32; April 1936.

282. WORRELL, F. M. "The Sound-on-Film Projector and the School Program." *American School Board Journal* 93: 48; July 1936.

Chapter III. Heating, Ventilation, and Sanitation in School Buildings

283. ACHESON, A. R. "School Ventilation." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 67-72.
284. ANDERSON, MARIUS. "Selecting a Stoker for a School Building." *Heating and Ventilating* 33: 24-25; December 1936.
285. "Atmospheric Control." *Architectural Record* 79: 510-12; June 1936.
286. "Automatic Control for Year 'Round Central Fan Systems." *Heating and Ventilating* 33: 47-50; May 1936.
287. BEALL, J. M. "Effective School Heating." *American School Board Journal* 94: 74; February 1937.
288. CANNEY, A. WARREN. "Effect of Air Conditioning on Building Design." *Architectural Record* 83: 72-81; February 1938.
289. "Chicago Air Conditioning Standards Finally Adopted." *Heating and Ventilating* 32: 29-30; December 1935.
290. "Estimating the Amount of Ventilation Air Necessary." *Heating and Ventilating* 32: 48-52; July 1935.
291. FALK, P. H. "Reducing Heating Cost of Lake Mills." *American School Board Journal* 92: 41-42; June 1936.
292. FELDMAN, A. M. "An Experiment with Ozone as an Adjunct to Artificial Ventilation." *Heating and Ventilating* 12: 35-36; March 1915.
293. FROMMELT, H. A. "Stoker Firing of School Boilers." *American School Board Journal* 91: 39-40; November 1935.
294. FROMMELT, H. A. "Stokers in School Heating." *American School Board Journal* 91: 26; August 1935.
295. HATTIS, ROBERT E. "63 Individual Ducts Serve Air Conditioned Spaces in Windowless Building." *Heating and Ventilating* 34: 31-34; June 1937.
296. HILL, E. VERNON. "Rational Psychromatics." *Heating, Piping and Air Conditioning* 9: 621-24; October 1937.
297. HOLY, T. C. "Modern Trends in Heating and Ventilation." *Harvard Educational Review* 7: 369-77; May 1937.
298. HOLY, T. C., chairman. "The School Plant." *Review of Educational Research* 5: 333-439; October 1935.
299. HOUGHTEN, F. C., and OTHERS. "Air Supply to Classrooms in Relation to Vent Flue Openings." *Transactions, 1935.* New York: American Society for Heating and Ventilating Engineers, 1935. p. 279-86.
300. HOUGHTEN, F. C., and OTHERS. "Classroom Drafts in Relation to Entering Air Stream Temperatures." *Transactions, 1935.* New York: American Society of Heating and Ventilating Engineers, 1935.
301. HOUGHTEN, F. C., and OTHERS. "Classroom Odors with Reduced Outside Air Supply." *Transactions, 1935.* New York: American Society of Heating and Ventilating Engineers, 1935.
302. HOUGHTEN, F. C., and YAGLOU, C. P. "Determination of the Comfort Zone." *Transactions, 1923.* New York: American Society of Heating and Ventilating Engineers, 1923. p. 361-84.
303. "Infiltration through Doors." *Heating, Piping and Air Conditioning* 33: 50-52; October 1936.
304. KEISER, WALTER. "Reducing Small Town School Ventilating Costs." *American School Board Journal* 68: 49-51; March 1924.
305. LEHMBERG, W. H.; BRANDT, A. D.; and MORSE, KENNETH. "Laboratory Study of Minimum Ventilation Requirements." *Transactions, 1935.* New York: American Society of Heating and Ventilating Engineers, 1935. p. 157-70.
306. LOEB, L. B. "The Nature of Ions in Air and Their Possible Physiological Effects." *Transactions, 1935.* New York: American Society of Heating and Ventilating Engineers, 1935. p. 101-18.
307. MCCULLOUGH, A. M. *A Critical Analysis of the Fuel Management Program for Schools.* Contributions to Education, No. 713. New York: Teachers College, Columbia University, 1937. 141 p.
308. MCCULLOUGH, A. M. "Most Heat for the Money." *Nation's Schools* 19: 64-68; March 1937.

309. MAGUIRE, DANIEL I. "Accepted Type of Access Chamber Toilet Room Design for New York City Schools." *Proceedings, 1936.* Nashville, Tenn.: National Council on Schoolhouse Construction (Sec.: R. L. Hamon, George Peabody College for Teachers), 1936. p. 36-38.
310. MILLS, C. A., and OLGE, CORDELIA. "Control of Body Heat Loss Through Radiant Means." *Heating, Piping and Air Conditioning* 9: 697-99; November 1937.
311. NATIONAL COUNCIL ON SCHOOLHOUSE CONSTRUCTION. *Proceedings, 1937.* Nashville, Tenn.: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1937. 135 p.
312. NEW YORK STATE COMMISSION ON VENTILATION. *Ventilation.* New York: Dutton and Co., 1923. 620 p.
313. NORMAN, R. A. *Study of Season Cost of Heating and Ventilating a Group of Iowa Public Schools.* Ames, Iowa: Iowa State College.
314. NOFFSINGER, FOREST R. "A Century of Progress in School Plumbing and Sanitation." *American School Board Journal* 94: 29-31, 50; January 1937.
315. NOFFSINGER, FOREST R. "A Century's Progress in School Heating and Ventilation." *American School Board Journal* 91: 38-39, July; 37-38, September; 36, November 1935. 92: 52, January; 30, April 1936.
316. RADDER, NORMAN J. "Old Toilets Go Modern." *Nation's Schools* 20: 63-65; December 1937.
317. REYNOLDS, T. W. "Care and Maintenance of Schoolhouse Heating and Ventilating System." *American School Board Journal* 91: 32; July 1935.
318. ROBERTSON, L. B. "Gas for Heating." *Nation's Schools* 20: 59-60; October 1937.
319. "School Buildings in England." *School and Society* 46: 604-606; November 6, 1937.
320. SCANLAN, CHESTER J., and JORDAN, R. V. "Modernizing School Heating and Ventilating Systems." *Heating and Ventilating* 32: 42; October 1935.
321. STURROCK, WALTER. "Effects of Artificial Lighting on Air Conditioning." *Heating, Piping and Air Conditioning* 10: 134-44; February 1938.
322. WAIT, G. R., and TORRESON, O. W. "Large-Ion and Small-Ion Content of Air in Occupied Rooms." *Transactions, 1935.* New York: American Society of Heating and Ventilating Engineers, 1935. p. 119-30.
323. "What Is Air Conditioning?" *Nation's Schools* 18: 43; December 1936.
324. WILKES, GORDON B., and BEMIS, ALAN C. "The Effect of Weather on the Heat Transmission of Walls." *Domestic Engineering* 147: 73-75; February 1936.
325. *Wisconsin Building Code.* Madison, Wis.: Superintendent of Public Property.
326. WISCONSIN INDUSTRIAL COMMISSION. *Heating, Ventilation and Air Conditioning Code.* Madison, Wis.: the Commission, 1936.
327. YAGLOU, C. P.; RILEY, E. C.; and COGGINS, D. I. "Ventilation Requirements." *Transactions, 1936.* New York: American Society of Heating and Ventilating Engineers, 1936. p. 133-62.
328. YAGLOU, C. P., and WITHERIDGE, W. N. "Ventilation Requirements." *Heating, Piping and Air Conditioning* 9: 447-50; July 1937.

Chapter IV. School Illumination

329. BOLLINGER, E. W. "Securing the Right Kind of Light." *Industrial Arts and Vocational Education* 22: 135-41; March 1933.
330. BRAINERD, ARTHUR A. "Judging Quality in Buying Lighting Equipment." *Buildings and Building Management* 33: 13-15; January 16, 1933.
331. CHAMBERLIN, JO. "Sight Saving." *Review of Reviews* 90: 40-43, 62; September 1934.
332. "Control of Light." *Architectural Record* 80: 406-407; November 1936.
333. COOPER, FRANK IRVING, chairman. "Illumination." *Report of the Committee on Schoolhouse Planning.* Washington, D. C.: National Education Association, 1925. Chapter 8, p. 90-121.
334. CORNET, G. A. "Modern Views on Lighting." *Nation's Schools* 19: 53-57; June 1937.
335. DARLEY, W. G. *Bibliography on School Lighting Recommendations Which Are Being Made Today.* Cleveland, Ohio: Nela Park Engineering Department, General Electric Company, April 25, 1938. 17 p.
336. DARLEY, W. G. "Light for Easier Seeing." *Nation's Schools* 20: 62, 64, 66; September 1937.

337. DATES, H. B. "Light—The Connecting Link Between the Eye and Education." *American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 224-26.
338. "Deeper Study Recommended (Editorial)." *Nation's Schools* 21: 17; February 1938.
339. DYSON, C. E. C. "Report on Safety Code for the Lighting of School Buildings." *Proceedings, 1932.* National Association of Public School Business Officials. Pittsburgh, Pa.: the Association (Sec.: H. W. Cramblet, 341 S. Bellefield Avenue), 1932. p. 58-61.
340. "An Experiment in Artificial Daylight." *Scientific American* 152: 331; June 1935.
341. FERREE, C. E., and RAND, G. "A Glareless Lighting Unit Adapted to the Classroom." *Nation's Schools* 12: 47-51; August 1933.
342. FLAGLER, LYLA D. "An Experiment in Classroom Illumination." *American School Board Journal* 96: 80, 82; January 1938.
343. FLOUNDERS, W. R. "Synthetic Daylight Aids Poor-Vision Pupils." *Electrical World* 103: 581; April 21, 1934.
344. FROSTIC, F. W. "Ancient and Dirty Light Fixtures Waste Power and Harm Eyes." *Nation's Schools* 12: 61-63; December 1933.
345. FROSTIC, F. W. "Automatic Light Control is Needed in the Modern School." *Nation's Schools* 12: 11-14; November 1933.
346. FUCHS, T. "Equipment for School Dramatics." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 267-76.
347. GAMBLE, D. L. "Light Reflecting Characteristics of Paint." *Industrial and Engineering Chemistry* 24: 875-81; August 1932.
348. GRADLE, H. S. "Lighting the Schoolroom." *Hygeia* 15: 1097-99; December 1937.
349. HALSEY, R. H. F. "How Much Light for Schoolrooms?" *American School Board Journal* 96: 27-28; January 1938.
350. HAMON, RAY L., and TAYLOR, LLOYD H. "What Effect Has the Horizontal Spacing of Classroom Windows on the Distribution of Light?" *Proceedings, 1933.* National Council on Schoolhouse Construction. Milwaukee: the Council (Sec.: W. C. Bruce), 1933. p. 40-44.
351. HARBESON, JOHN W. "Planning Better Plants for Upper Secondary Schools." *American School Board Journal* 96: 64-65, 108; January 1938.
352. HARRISON, W. K., and FOUILHOUX, J. A. "The Design of Classroom Windows." *School Executive* 57: 28-29; September 1937.
353. HARRISON, W. K., and WEITZ, C. E. *Illumination Design Data.* Cleveland, Ohio: Nela Park Engineering Department, General Electric Company, 1936. 69 p.
354. HARRISON, W. K., and FOUILHOUX, J. A. "Location of Classroom Windows." *Nation's Schools* 20: 53-56; December 1937.
355. HATHAWAY, WINIFRED. "Room Design and Equipment Requirements for Sight-Saving Classes." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 245-51.
356. HENDERSON, O. G., and ROWELL, H. G. "Eye Protection in Every Classroom." *American School and University, 1933-34.* New York: American School Publishing Corp., 1933. p. 230-33.
357. HERRIOTT, M. E. "Schoolroom Seating for Better Natural Lighting and the Informal Program." *American School Board Journal* 91: 39-40; December 1935.
358. HITCH, A. M. "Measuring Light for Study." *Nation's Schools* 12: 51-52; September 1933.
359. HOLMES, W. J. "Good Lighting and Good Scholarship." *School Executive* 57: 72-73; October 1937.
360. ILLUMINATING ENGINEERING SOCIETY. *Transactions, 1930-1938.* New York: the Society (51 Madison Avenue), 1930-38. 9 vols.
361. ILLUMINATING ENGINEERING SOCIETY and the AMERICAN INSTITUTE OF ARCHITECTS. *American Recommended Practice of School Lighting.* New York: Illuminating Engineering Society, 1938. 60 p.
362. IVES, JAMES E. "A Review of the Current Practice of the Lighting of School Buildings in the United States." *American School and University, 1929-30.* New York: American School Publishing Corp., 1929. p. 286-89.

363. JOHNSTON, H. L. "Better School Lighting Pays." *Electrical World* 104: 1078; December 8, 1934.

364. LADD, G. O. *An Illumination Survey of Certain Buildings of the University of Missouri.* Master's thesis. Columbia, Mo.: University of Missouri, 1935.

365. LAYTON, C. M. "Automatic Lighting and Scholarship." *American School Board Journal* 92: 49, 86; January 1936.

366. LOGAN, H. L. "Lighting the Classroom More Effectively With Less Illumination." *Architectural Record* 75: 533; June 1934.

367. LUCKIESH, MATTHEW. "Relative Foot Candles." *Electrical World* 99: 107; January 9, 1932.

368. LUCKIESH, MATTHEW, and MOSS, FRANK K. *The Science of Seeing.* New York: D. Van Nostrand Co., 1937. 548 p.

369. LUCKIESH, MATTHEW, and MOSS, FRANK K. *Seeing: A Partnership of Lighting and Vision.* Baltimore: Williams and Wilkins Co., 1931. 241 p.

370. LUCKIESH, MATTHEW. *Seeing and Human Welfare.* Baltimore: Williams and Wilkins Co., 1934. 190 p.

371. MCDONALD, ANGUS S. "Effective Library Lighting." *Architectural Forum* 56: 631-34; June 1932.

372. MCKELVY, H. E. *A Study to Determine the Economy Attained in the Use of Artificial Illumination in Knoxville Junior High School.* Master's thesis. Pittsburgh, Pa.: University of Pittsburgh, 1934.

373. MARTIN, A. J. "Schoolroom Daylighting." *American School Board Journal* 82: 65, 138; May 1931.

374. NATIONAL COUNCIL ON SCHOOLHOUSE CONSTRUCTION. *Proceedings, 1937.* Nashville, Tenn.: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1937. 135 p.

375. NATIONAL SAFETY COUNCIL. *Lighting and Health.* Health Practice Pamphlet No. 18. Chicago: the Council, 1936.

376. NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS. *Lighting the Schoolroom.* Publication No. 5(c). New York: the Society, 1933. 3 p.

377. "New Standards for School Lighting." *American School Board Journal* 86: 41, 74; January 1933.

378. "New York's Lighting Survey." *Nation's Schools* 21: 74; February 1938.

379. NOFFSINGER, FOREST R. "A Century of Progress in Schoolroom Lighting." *American School Board Journal* 96: 41-42, 89; April 1938.

380. PALMER, R. A. "New Light on Lighting." *Nation's Schools* 19: 51-54; February 1937.

381. PIERCE, R. T. "Seeing Things in a New Light." *Nation's Schools* 18: 48-50; July 1936.

382. POWELL, A. L. "Practical Suggestions on the Artificial Lighting of School Buildings." *American School and University, 1928-29.* New York: American School Publishing Corp., 1928. p. 37-42.

383. "Proposed Lighting Standards." *Nation's Schools* 21: 66; February 1938.

384. RODGERS, ALSTON. "Control of Light." *Architectural Record* 79: 504-509; June 1936.

385. RODIN, F. H. "Lighting Problems in Lip Reading." *Volta Review* 34: 367; August 1932.

386. SAUPE, W. J., and ELLIOTT, E. A. *An Outline of the Joplin, Missouri, Research to Determine the Influence of Controlled Classroom Lighting upon Scholarship.* Unpublished report. Columbia, Mo.: University of Missouri, 1938.

387. SCHNURMACHER, H. C. "Measuring Light with the Electric Eye." *National Safety News* 29: 24; January 1934.

388. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *Bibliography of College and University Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 10, No. 2. Bloomington, Ind.: Indiana University, 1934. p. 155-56.

389. SMITH, HENRY LESTER, and CHAMBERLAIN, LEO MARTIN. *A Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 4, No. 3. Bloomington, Ind.: Indiana University, 1928. p. 220-31.

390. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *A Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 9, No. 3. Bloomington, Ind.: Indiana University, 1933. p. 42-47.
391. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *A Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 11, No. 2. Bloomington, Ind.: Indiana University, 1935. p. 128-33.
392. SMITH, MARY EMMA. *A Program of Eye Health in a School System.* Publication No. 143. New York: National Society for the Prevention of Blindness, 1934. 14 p.
393. STURROCK, WALTER. "Better Lighting in School Buildings." *School Executive* 55: 97-99, 113; November 1935.
394. STURROCK, WALTER. "Planning Artificial Lighting for School Buildings." *American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 275-82.
395. STURROCK, WALTER. "The School-Shop Lighting Problem." *Industrial Arts and Vocational Education* 22: 45-50; February 1933.
396. SWARD, G. G. "What a School Man Should Know About Paint." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 219-22.
397. TINKER, M. A. "Illumination and the Hygiene of Reading." *Journal of Educational Psychology* 25: 669-80; December 1934.
398. UHLER, W. P. "The Eyes Have It." *Nation's Schools* 15: 53-54; May 1935.
399. "Use Wall Paint That Reflects Light." *Factory and Industrial Management* 83: 418-19; November 1932.
400. ZAHOUR, R. L. "Modern Practice in School Lighting." *American School and University, 1932-33.* New York: American School Publishing Corp., 1932. p. 39-41.

Chapter V. Cost of School Buildings

401. ALEXANDER, CARTER, and COVERT, TIMON. *Bibliography on Educational Finance, 1923-1931.* U. S. Dept. of the Interior, Office of Education, Bulletin, 1932, No. 15. Washington, D. C.: Government Printing Office, 1932. 343 p.
402. CLARK, HAROLD F. *Index Numbers in School Administration.* Bulletin of the School of Education, Vol. 3, No. 3, Bloomington, Ind.: Indiana University, 1927. 35 p.
403. COONS, GEORGE D., and ESSEX, DON L. "The Distribution of School-Building Costs." *American School Board Journal* 90: 38-39, 77; June 1935.
404. ENGELHARDT, N. L., and ENGELHARDT, FRED. *Planning School Building Programs.* New York: Teachers College, Columbia University, 1930. Chapter 16, "School Building Costs," p. 388-431.
405. ENGELHARDT, N. L.; MORPHET, E. L.; and HORTON, E. H. *School Building Bibliography up to October 1926 with Annotations.* Unpublished manuscript. New York: Teachers College, Columbia University, 1926. p. 106-25.
406. ENGELHARDT, N. L. *School Building Program for Cities.* Contributions to Education, No. 96. New York: Teachers College, Columbia University, 1918. 130 p.
407. ESSEX, DON L. "Incidental Costs of School Building." *School Executive* 56: 14, 30; September 1936.
408. GROSSNICKLE, FOSTER E. *Capital Outlay in Relation to a State's Minimum Educational Program.* Contributions to Education, No. 464. New York: Teachers College, Columbia University, 1931. 67 p.
409. HART, F. W., and PETERSON, L. H. "Economies in Schoolhousing." *American School Board Journal* 73: 42, 153; July 1926.
410. HOLY, T. C., and ARNOLD, W. E. "School-Building Expenditures in Relation to School-Building Costs." *American School Board Journal* 85: 41-42; July 1932.
411. MISNER, FRANK M. *Extra Costs and Incidental Costs in the Erection of School Buildings.* Contributions to Education, No. 624. New York: Teachers College, Columbia University, 1934. 79 p.
412. MORSE, HERBERT N., and ANDERSON, CHARLES D. "Methods of Computing and Comparing School-Building Costs." *American School and University, 1929-1930.* New York: American School Publishing Corp., 1929. p. 22-25.
413. PUGMIRE, D. ROSS. "The Character of the Contractors' Bidding on School Buildings." *The Planning and Construction of School Buildings.* Thirty-Third Yearbook, Part I, National Society for the Study of Education. Bloomington, Ill.: Public School Publishing Co., 1934. Chapter 28, p. 271-75.

414. SCHERER, FRANCIS R. "Comparative Costs of School Buildings at Rochester, New York." *American School Board Journal* 68: 56-57; February 1924.
415. SMITH, HENRY LESTER, and CHAMBERLAIN, LEO MARTIN. *A Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 4, No. 3. Bloomington, Ind.: Indiana University, 1928. 326 p.
416. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 9, No. 2. Bloomington, Ind.: Indiana University, 1933. 182 p.
417. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 9, No. 3. Bloomington, Ind.: Indiana University, 1933. 130 p.
418. SMITH, HENRY LESTER, and NOFFSINGER, FOREST RUBY. *Bibliography of School Buildings, Grounds, and Equipment.* Bulletin of the School of Education, Vol. 11, No. 2. Bloomington, Ind.: Indiana University, 1935. 216 p.
419. VINCENT, JOSEPH JOHNSON. *The Cost of Elementary School Buildings in Texas.* Master's thesis. Austin, Texas: University of Texas, 1929.

Chapter VI. Foreign School Buildings

General

420. Le Bureau International d'Education. *La Législation Régissant les Constructions Scolaires.* Publication nombre 47. Génève: le Bureau, 1936. 200 p.
421. DAVIS, MARY DABNEY. "The Housing of Schools for Young Children in European Countries." *American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 237-44.
422. "Europe Shelters Education." *Architectural Forum* 62: 65-80; January 1935.
423. "The School Illustrated." *Architects Journal* 83: 807-30; May 28, 1936.
424. WOODBRIDGE, FREDERICK J. "Ideas From European Schools." *Architectural Forum* 55: 725-30; December 1931.

Denmark

425. *Skolebygninger Og Skolens Indre Forhold.* Betaenking Afgivet Af Kommissionen Til Droftelse Skolens Navnlig Folkeskolens Hygiejnikske Forhold Og Opgaver. Kobenhaven: A/S J. H. Schultz Bogtrykker, 1937. p. 71-130.
426. "Skolekonkurrencerne, Kobenhavnske Kommuneskoler, Roskilde Katedralskole." *Arkitekten (Skole Nummer)*, Marts-April 1938. 108 p.
427. "Skolen Og Dens Indretning." *Arkitekten*, Januar-Februar 1933. 60 p.

England

428. *Architects Journal.* (A series of sections contained each week from November 4, 1937 to January 21, 1938.) Westminster, England: Architectural Press.
429. CLAY, SIR FELIX. *Modern School Buildings.* London: B. T. Batsford Ltd., 1929. 208 p.
430. Great Britain. Board of Education. *Suggestions for the Planning of Buildings for Elementary Schools.* Educational Pamphlet No. 107. London: H. M. Stationery Office, 1936. 129 p.
431. Great Britain. Board of Education. *Suggestions for the Planning of New Buildings for Secondary Schools.* Educational Pamphlet No. 86. London: H. M. Stationery Office, 1931. 94 p.
432. National Union of Teachers. *School Buildings.* ("The General Problem" by John Sargent; "Progress of the Investigation" by A. H. Seymour.) London: the Union, 1932. 29 p.

France

433. *L'Architecture d'Aujourd'hui* [*School Number*] 5: 5-77; May 1935.
434. BEAUDOUIN, EUGÉNE, and LODS, MARCEL. "The Fresh Air School, Suresnes, France." *American Architect* 147: 34-37; November 1935.

435. BRÈS, S. *Construction et Aménagement des Écoles Maternelles.* Paris: Librairie Ch. Delagrave. 47 p.
436. "Écoles Maternelles," "Écoles Primaries," "Écoles Superiures." *L'Architecture d'Aujourd'hui* 7: 4-79; May 1936.
437. ENGELHARDT, N. L. "New Elementary Schools in Paris." *School Executive* 51: 450; June 1932.
438. POULAIN, ROGER. *Écoles.* Paris: Vincent Freal et Cie, 1923. 104 p.

Germany

439. *Der Baumeister.* (Monthly magazine on architecture and construction.) Munchen, Germany: George D. W. Callway, December 1930.
440. *Bauwelt.* Berlin, Germany: A. G. Ullstein. p. 22-26, October 31, 1929; p. 4, April 18, 1931; p. 17-30, June 11, 1931.
441. HANE, MORITZ. *Der Schulbau. (Normen, Richtlinien und Ratschläge fur den Schulbau).* Berlin, Germany: Weidmannsche Buchhandlung, 1931. 166 p.
442. *Das Neue Schulhaus.* Second enlarged edition. Leipzig, Germany: Leipziger Lehrerzeitung, 1930. 160 p.
443. SCHÜTTE, VON REGIERUNGSBAUMEISTER. "Der Moderne Volksschulbau." *International Education Review (Erstes Heft)* 1931-1932. p. 87-91.
444. *Stein, Holz, Eisen.* Frankfurt am Main, Germany: Stein Holz Eisen (Morfelder Landstrasse Nummer 109), August 15, 1929.
445. VISCHER, JULIUS. *Der Neue Schulbau.* Stuttgart, Germany: Julius Hoffmann, 1931. 102 p.

Italy

446. *L'Architectura Italiana* [*School Number*] 30: 79-104; March 1935.
447. ENGELHARDT, N. L. "An Open-Air School in Rome, Italy." *School Executive* 51: 351; April 1932.
448. ENGELHARDT, N. L. "New Schools in Florence, Italy." *School Executive* 51: 410-11; May 1932.
449. ENGELHARDT, N. L. "The Umberto Di Savoia Open-Air School, Milan, Italy." *American School and University, 1933-1934.* New York: American School Publishing Corp., 1933. p. 50-51.
450. MINNUCI, GAETANO. *Scuole.* Milan, Italy: Ulrico Hoepli, 1936. 277 p.
451. SECCHI, LUIGI L. *Edifici Scholastici Italiani, Primari E Secondari.* Milan, Italy: Ulrico Hoepli, 1927. 228 p.

Netherlands

452. ROTHUIZEN, E. J.; KOCKX, H. J.; EN BRANTS, K. *Scholenbouw.* Goes: Osterbaan en Le Cointre, 1924. 190 p.
453. YERBURY, F. R. *Modern Dutch Buildings.* London: Ernest Benn, Ltd., 1931. 100 p.

Mexico and South America

454. *Bulletin of the Pan American Union.* Published monthly. Washington, D. C.
455. Conceptos sobre, Edificació Escolar en la República Argentina. (Con fotografías de edificios escolares.) *Revista de Arquitecture,* Febrero de 1935, p. 60-67. Buenos Aires, Argentina.
456. "Federal Schools of Mexico." *Architectural Record,* May 1936.
457. Reorganización de la Oficina de Inspección de Construcciónes Escolares con el carácter de Oficina de Arquitectura e Inspección de Construcciónes Escolares. La Gaceta, San José: 12 junio 1926. p. 783.
458. *Revista de las Indias.* Volumen 1, Numero 6, Julio de 1937. Bogota, Colombia: Ministerio de Educacion Nacional.
459. Tipo de escuela rural y primaria qui propone la Oficina Técnica de Proyectos y Presupuestos de la Secretaría de Educación. El Maestro Rural, Mexico, 1 agoste 1933. p. 19-21.

Sweden

460. INOM KUNGL. Ecklesiastikdepartementet Tillkallade Sakkunniga. *Normalritningar Till Skolanlaggningar For Folkskolan Jamte Anvisningar Och Beskrivningar.* Göteborg, Sweden: Sachrissons Boktryckeri, 1920.

461. "Overstyrelsen For Stockholms Stads Folkskolor." *Folkskolebyggnader.* Stockholm, Sweden: Ivar Haeggströms Boktryckeri Aktiebolag, 1912.

Chapter VII. Technics of School Building Surveys

462. CARPENTER, W. W., and ROSENSTENGEL, W. E. "Participation of State Universities in School Plant Surveys." *School Executives Magazine* 52: 122-23; November 1932.

463. CARPENTER, W. W. "A School-Building-Survey Work Sheet." *American School Board Journal* 83: 57, 108; August 1931.

464. CASWELL, HOLLIS L. "Definition and Classification of Surveys." *Peabody Journal of Education* 10: 179-81; November 1932.

465. CASWELL, HOLLIS L. "School Surveys and Their Influence on Building Problems." *Nation's Schools* 5: 66-71; April 1930.

466. CASWELL, HOLLIS L. "Survey Techniques." *Educational Administration and Supervision* 19: 431-41; September 1933.

467. CINCINNATI PUBLIC SCHOOLS. *Survey of Sites, Buildings, and Equipment.* Cincinnati, Ohio: Bureau of School Research, 1938. 2 vol.

468. COOPERATIVE STUDY OF SECONDARY SCHOOL STANDARDS. *The School Plant.* Evaluative Criteria Section K (Revised edition). Washington, D. C.: Cooperative Study (744 Jackson Place), 1938.

469. HALSEY, R. H. F. "What Unit Should Be Used for Cost Comparisons of Schoolhouses?" *Proceedings, 1934.* National Council on Schoolhouse Construction. Nashville, Tenn.: the Council (Sec.: R. L. Hamon, George Peabody College for Teachers), 1934. p. 18-23.

470. HOLY, T. C. "Making a Scientific School Plant Survey." *Nation's Schools* 7: 21-27; April 1931.

471. HOLY, T. C. "School Building Surveys." *Educational Research Bulletin (Ohio State University)* 8: 318-19, 331; October 9, 1929.

472. IRONS, G. E. "Planning for New School Buildings With Graphic Records." *American School Board Journal* 83: 47-48, 108-11; August 1931.

473. MOEHLMAN, ARTHUR B. "Schoolhouse Planning." *Nation's Schools* 7: 84-90, March; 84-88, April; 80-84, May; 78-82, June 1931.

474. SEARS, JESSE B. "The School Survey Movement." *Modern School Administration.* (Edited by John C. Almack.) Boston: Houghton Mifflin Co., 1933. Chapter 8, p. 217-59.

475. STRAYER, GEORGE D., and ENGELHARDT, N. L. *Classification of Procedures to be Followed in the Development of a School Survey.* New York: Teachers College, Columbia University, 1931. 131 p. (Mimeo.)

476. WOOD, FRANK H. "School Surveys and School Board Planning." *American School Board Journal* 86: 19-20, 77-78; January 1933.

Chapter VIII. Plant Development for Higher Education, Including Junior Colleges

477. BLEWETT, EDWARD YORK. "The Control and Maintenance of College Outdoor Athletic Facilities." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 296-99.

478. BOZORTH, INEZ V. "Dormitory Design and Equipment." *The American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 302-306.

479. CARPENTER, W. W. "Buildings Planned for Junior College Programs." *Junior College Journal* 7: 498-501; May 1937.

480. CARPENTER, W. W. "The Junior-College Building and Its Equipment." *The American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 39-45.

481. CARPENTER, W. W. "Planning the Junior College Building." *Junior College Journal* 6: 63-68; November 1935.

482. CHAMBERLAIN, L. M. Review of C. D. Hardesty's "Problems and Practices in Housing the Junior College Program in California." *Junior College Journal* 7: 203-204; January 1935.

483. COLEMAN, HARRY S. "Planning and Equipping Laboratories for Research." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 527-35.

484. CUNNINGHAM, HARRY A. "Rooms, Service and Furnishings for Biology Departments in Teachers Colleges." *The American School and University, 1933-34.* New York: American School Publishing Corp., 1933. p. 310-14.

485. EELLS, WALTER CROSBY. "Junior College Libraries." *Junior College Journal* 6: 202-206; January 1936.

486. EVENDEN, E. S.; STRAYER, GEORGE D.; and ENGELHARDT, N. L. *Standards for College Buildings.* New York: Teachers College, Columbia University, 1938. (In press.)

487. FOULK, W. B. "Servicing a Modern Laboratory from a Central Delivery Room." *The American School and University, 1933-34.* New York: American School Publishing Corp., 1933. p. 298-305.

488. HADDEN, GAVIN. "Indoor Play Facilities for College Women." *The American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 189-90.

489. HANLEY, EDNA R. "Work Rooms in College and University Libraries." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 339-44.

490. HARBESON, J. W. "Building Program at Pasadena." *Junior College Journal* 7: 47; October 1936.

491. HARTENSTEIN, PAUL B.; BUTTS, PORTER; and LAUTERBACH, CARL. "The Student Union." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 477-83.

492. HOOVER, C. R. "Recent Trends in Laboratory Construction, with Special Reference to Chemical Laboratories." *The American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 339-43.

493. HUBBARD, HENRY V., and ZACH, LEON HENRY. "The Landscape Architect's Part in Planning Colleges and Schools." *The American School and University, 1935.* New York: American School Publishing Corp., 1935. p. 155-60.

494. INGEMANN, WILLIAM M. "Planning Men's Dormitories for Today and Tomorrow." *The American School and University, 1933-34.* New York: American School Publishing Corp., 1933. p. 275-78.

495. JOHNSON, FRANKLIN W. "Some Factors Involved in Planning a New College Campus." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 23-26.

496. JOHNSON, FREDERIC B. "Maintenance and Operation of a University Plant." *The American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 152-54.

497. KISSACK, ROBERT A., JR. "A Visual Education Service at the College Level." *The American School and University, 1937.* New York: American School Publishing Corp., 1937. p. 291-97.

498. KRAEHENBUEHL, JOHN O. *An Investigation of Student Study Lighting.* Experiment Station Circular No. 28. Urbana: University of Illinois, 1937. 35 p.

499. LAVERTY, WAYNE H. "The Maintenance of University Grounds." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 266-68.

500. LOWRY, WILLIAM J. "A Bibliography of Fifty Outstanding Books on School and College Buildings and Allied Topics." *The American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 60-62.

501. NATIONAL RESEARCH COUNCIL, COMMITTEE ON CONSTRUCTION AND EQUIPMENT OF CHEMICAL LABORATORIES. *Report.* New York: Chemical Foundation, 1930. 340 p.

502. RANDALL, WILLIAM M. "The Physical Administration of the Book Collection." *The American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 261-64.
503. REID, WILLIAM A. "Cork-Surfaced Tennis Courts at Colgate University." *The American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 215-17.
504. SHEPHERD, HARRY WHITCOMB. "Landscape Architecture for the Grounds of Educational Centers." *The American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 258-65.
505. STETSON, WILLIS K. "A Summary of the Latest Developments and Improvements in Buildings, Equipment, and Supplies." *Library Journal* 63: 87-88; January 1938.
506. TILTON, EDWARD L. "College Library Planning." *The American School and University, 1933-34.* New York: American School Publishing Corp., 1933. p. 225-29.
507. WALFORD, J. BINFORD. "Dormitory Design." *The American School and University, 1936.* New York: American School Publishing Corp., 1936. p. 347-51.

Chapter IX. Pupil Transportation Equipment

508. BELKNAP, BURTON H. "Bus Economy, Comfort, and Safety in Rural New York State." *Nation's Schools* 20: 55; July 1937.
509. BELKNAP, BURTON H. *Transportation Data for 114 Central Districts, School Year, 1932-33.* University of the State of New York Bulletin 1047. Albany: New York State Education Department, 1934. 11 p.
510. CALIFORNIA DEPARTMENT OF EDUCATION. *The Regulation of Pupil Transportation.* Bulletin No. 2. Sacramento: the Department, 1937. 31 p.
511. EVANS, FRANK O. *Factors Affecting the Cost of School Transportation in California.* U. S. Dept. of the Interior, Office of Education, Bulletin, 1930, No. 10. Washington, D. C.: Government Printing Office, 1930. 42 p.
512. JOHNS, R. L. *State and Local Administration of School Transportation.* Contributions to Education, No. 330. New York: Teachers College, Columbia University, 1928. 134 p.
513. JOHNS, R. L. *State Support for School Transportation.* Montgomery, Ala.: Alabama Education Association, March 1935. 23 p.
514. LAMBERT, A. C. *The Costs of Transporting School Children by Vehicles in the Utah Consolidated School Districts.* Salt Lake City, Utah: Department of Public Instruction, 1931. 75 p.
515. NATIONAL EDUCATION ASSOCIATION, RESEARCH DIVISION. "Safety in Pupil Transportation." *Research Bulletin* 14: 199-238; November 1936.
516. NATIONAL SAFETY COUNCIL. *School Buses: Their Safe Design and Operation.* Chicago: the Council, 1933. 11 p.
517. NOBLE, M. C. S., JR. *Public School Bus Transportation in North Carolina, 1930-31.* Publication No. 172. Raleigh, N. C.: State Department of Public Instruction, 1931. 102 p.
518. OHIO DEPARTMENT OF EDUCATION. *Factors Related to the Cost of Pupil Transportation in Ohio.* (A typewritten report of the W. P. A. pupil transportation study by C. D. Hutchins, Project No. 7-25-5015.) 1937. 216 p.
519. OHIO DEPARTMENT OF HIGHWAYS, DIVISION OF STATE HIGHWAY PATROL. *First Annual Report.* 1934. 49 p. (Mimeo.)
520. OKLAHOMA DEPARTMENT OF EDUCATION, DIVISION OF RESEARCH AND SERVICE. *Statistics Pertaining to Pupil Transportation in Oklahoma, 1931-1932.* Bulletin No. 136. Oklahoma City: the Department, 1933. 111 p.
521. REYNOLDS, THOMAS SHELDON. *School Transportation in Kentucky 1935-36.* Educational Bulletin, Vol. 4, No. 11. Frankfort, Ky.: Department of Education, 1937. 45 p.
522. ROBERTS, ROY W. *An Analysis of the Cost of Pupil Transportation in Arkansas.* Bulletin No. 316. Agricultural Experiment Station. Fayetteville, Ark.: University of Arkansas, 1935. 31 p.
523. "Transportation of Public School Pupils in California." *California Schools* 5: 194-206; June 1934.
524. WILLIAMS, R. C. *Cost of Pupil Transportation in Consolidated Schools of Iowa.* Research Bulletin No. 22. Des Moines, Iowa: State Department of Education, 1938. 31 p.

Chapter X. State Studies of Local School Units as Related to the School Plant

525. ALABAMA STATE DEPARTMENT OF EDUCATION. *Narrative Report 1935-36-37: Part I.* Bulletin No. 10. Montgomery, Ala.: the Department, 1937. 117 p.

526. ALABAMA STATE DEPARTMENT OF EDUCATION. *Report of the Survey of Elmore County Schools, School Year 1927-28.* Montgomery, Ala.: the Department, 1929. 123 p.

527. ARIZONA STATE DEPARTMENT OF EDUCATION. *Study of Local School Units in Arizona.* Phoenix, Ariz.: the Department, 1937.

528. ARKANSAS STATE DEPARTMENT OF PUBLIC INSTRUCTION. *Study of Local School Units in Arkansas.* Little Rock, Ark.: the Department, 1937. 214 p.

529. ARKANSAS STATE DEPARTMENT OF PUBLIC INSTRUCTION. *A Survey of the Public Schools of Arkansas.* Little Rock, Ark.: the Department, 1932.

530. BRISCOE, ALONZO OTIS. *The Size of the Local Unit for Administration and Supervision of Public Schools.* Contributions to Education, No. 649. New York: Teachers College, Columbia University, 1935. 110 p.

531. CALIFORNIA STATE DEPARTMENT OF EDUCATION. *Study of Local School Units in California.* Sacramento: the Department, 1937. 137 p.

532. CAVINS, L. V., and STAFF. *An Administrative Survey of Ritchie County, West Virginia.* Charleston, W. Va.: State Department of Education, 1934.

533. COOK, KATHERINE M., editor. *Reorganization of School Units.* U. S. Dept. of the Interior, Office of Education, Bulletin, 1935. No. 15. Washington, D. C.: Government Printing Office, 1936. 91 p.

534. COVERT, TIMON. *Larger Units for Educational Administration a Potential Economy.* U. S. Dept. of the Interior, Office of Education, Pamphlet No. 45. Washington, D. C.: Government Printing Office, 1933. 43 p.

535. CRESSMAN, GEORGE R. *Local Units for School Administration: Studies in Selected Counties in Pennsylvania and Maryland.* Doctor's thesis. Philadelphia: University of Pennsylvania, 1932. 266 p.

536. DAWSON, HOWARD A., and OTHERS. *An Administrative Survey of the Public Schools of Mercer County, West Virginia.* Charleston, W. Va.: State Department of Education, 1932. 128 p.

537. DAWSON, HOWARD A.; COLEMAN, J. E.; and HENRY, W. W. *An Educational Survey of Clay County, Arkansas.* Little Rock, Ark.: Arkansas State Department of Education, 1930.

538. DAWSON, HOWARD A., and HENDERSON, D. T. *An Educational Survey of Pulaski County Rural Schools.* Little Rock, Ark.: Pulaski County Board of Education, 1930.

539. DAWSON, HOWARD A. *An Educational Survey of the Public Schools in Mississippi County, Arkansas.* Blytheville, Ark.: Mississippi County Board of Education, 1928.

540. DAWSON, HOWARD A. *Satisfactory Local School Units.* Field Study No. 7. Nashville, Tenn.: Division of Surveys and Field Studies, George Peabody College for Teachers, 1934. 180 p.

541. DEFFENBAUGH, W. S., and COVERT, TIMON. *School Administrative Units with Special Reference to the County Unit.* U. S. Dept. of the Interior, Office of Education, Pamphlet No. 34. Washington, D. C.: Government Printing Office, 1933. 25 p.

542. FLORIDA STATE DEPARTMENT OF PUBLIC INSTRUCTION. *A Study of Broward County Schools.* Tallahassee, Fla.: the Department, 1938.

543. HYDE, RICHARD E. "Survey of Local School Attendance Units in West Virginia." (Abstract.) *The Role of Research in Educational Progress.* Official Report, 1937. Washington, D. C.: American Educational Research Association, a Department of the National Education Association, 1937. p. 16-18.

544. ILLINOIS EDUCATIONAL COMMISSION. *Report of the Advisory Staff Made to the Illinois Educational Commission.* Springfield, Ill.: the Commission, 1935. 19 p.

545. ILLINOIS STATE SUPERINTENDENT OF PUBLIC INSTRUCTION. *Study of Local School Units in Illinois.* Springfield, Ill.: the Superintendent, 1937. 158 p.

546. KENTUCKY STATE DEPARTMENT OF EDUCATION. *Report of the Kentucky Educational Commission.* Educational Bulletin, Vol. I, No. 8. Frankfort, Ky.: the Department, 1933. 324 p.

547. KENTUCKY STATE DEPARTMENT OF EDUCATION. *Study of Local School Units in Kentucky.* Frankfort, Ky.: the Department, 1937. 126 p.
548. LEE, CHARLES A., and CHENAULT, PRICE. "Recent Trends in School-Plant Planning." *Review of Educational Research* 5: 393-405, 437-39; October 1935.
549. LITTLE, H. A. *Potential Economies in the Reorganization of Local School Attendance Units.* Contributions to Education, No. 628. New York: Teachers College, Columbia University, 1934. 78 p.
550. MISSOURI STATE SUPERINTENDENT OF SCHOOLS. *Eighty-third Report of the Public Schools of the State of Missouri—for the School Year Ending June 30, 1932.* Jefferson City, Mo.: the Superintendent, 1933. 1656 p.
551. MORPHET, EDGAR L. "Capital Outlay in the School Finance Program." *American School Board Journal* 94: 19-20, 99; June 1937. 95: 19-21; July 1937.
552. NORTH CAROLINA STATE DEPARTMENT OF PUBLIC INSTRUCTION. *Study of Local School Units in North Carolina.* Raleigh, N. C.: the Department, 1937. 191 p.
553. OHIO STATE DEPARTMENT OF EDUCATION. *Study of Local School Units in Ohio.* Columbus, Ohio.: the Department, 1937. 271 p.
554. OHIO STATE DEPARTMENT OF EDUCATION. *A Study of the Public Schools of Lawrence County.* Columbus, Ohio: the Department, 1937. 95 p. (Similar studies were prepared for each of the other 87 counties in Ohio.)
555. OKLAHOMA STATE DEPARTMENT OF EDUCATION. *Study of Local School Units in Oklahoma.* Oklahoma City, Okla.: the Department, 1937.
556. PENNSYLVANIA STATE DEPARTMENT OF PUBLIC INSTRUCTION. *Study of Local School Units in Pennsylvania.* Harrisburg, Pa.: the Department, 1937. 150 p.
557. RUSSELL, JOHN DALE, and SHELBURNE, JAMES C. "Organization of Administration in Institutions of Higher Education." *Review of Educational Research* 7: 400-404; October 1937.
558. TENNESSEE EDUCATIONAL COMMISSION. *Report, Part II: Recommendations Affecting Public Education in Tennessee.* Nashville, Tenn.: the Commission, 1934. 132 p.
559. TENNESSEE STATE DEPARTMENT OF EDUCATION. *A Study of Local School Units in Tennessee.* Nashville, Tenn.: the Department, 1937. 206 p.
560. TEXAS STATE DEPARTMENT OF EDUCATION. *Biennial Report of the State Board of Education—1932-34.* Bulletin No. 339. Vol. 10, No. 12. Austin, Texas: the Department, December 1934. 217 p.
561. THOMPSON, GEORGE E. *School Costs in Kane County, Illinois.* Master's thesis. Chicago: University of Chicago, 1934. 92 p.
562. TINK, EDMUND LEWIS. *Certain Phases of County Educational Organization with Special Reference to Florida.* Contributions to Education, No. 363. New York: Teachers College, Columbia University, 1929. 103 p.
563. U. S. DEPARTMENT OF THE INTERIOR, OFFICE OF EDUCATION. *Handbook of Procedures for Planning the Reorganization of Local School Units.* Circular 156. Washington, D. C.: the Office, January 1936. 54 p.
564. U. S. DEPARTMENT OF THE INTERIOR, OFFICE OF EDUCATION. *Handbook of Suggested Procedures for the Reorganization of Local School Units and the Projection of School Building Programs.* Washington, D. C.: the Office, 1935. 20 p. (Mimeo.)

Chapter XI. Trends in School Architecture and Design

565. ACKERMAN, FREDERICK. Quoted in the Editor's Diary. *Architects' World* 1: 143; March 1938.
566. BARROWS, ALICE. *Functional Planning of Elementary School Buildings.* U. S. Dept. of the Interior, Office of Education, Bulletin, 1936. No. 19. Washington, D. C.: Government Printing Office, 1937. 83 p.
567. BARROWS, ALICE. Quoted in *Architects' World* 1: 163; April 1938.
568. BETELLE, JAMES O. "The Trend in School Building Design." *Architecture* 65: 249-52; May 1932.
569. DAVIS, H. H. "Implications of Progressive Education for School Plant and Equipment." *American School Board Journal* 89: 25-26; July 1934.

570. ENGELHARDT, N. L. "The School of Tomorrow." *American Architect and Architecture* 150: 37-40; April 1937.
571. HAESLER, OTTO. "A German Public School at Celle." *American Architect* 138: 24-27; August 1930.
572. "Hollywood High School." *Architectural Forum* 68: 232; March 1938.
573. ITTNER, WILLIAM B. "Fundamentals in Planning School Buildings." *Architectural Forum* 48: 305-36; March 1928.
574. ITTNER, WILLIAM B., and OTHERS. "School Building Reference Number." *Architectural Forum* 37: 45-114; August 1922.
575. LESCAZE, WILLIAM C. "The New Ansonia (Conn.) High School." *School Management* 7: 88-89; November 1937.
576. LICHT, LAWRENCE C. "The Englewood (New Jersey) High School." *American Architect* 144: 14-17; March 1934.
577. LURÇAT, ANDRÉ. "School at Villejuif, France." *American Architect* 144: 19-20; March 1934.
578. SCHNITMAN, L. SETH. "Recovery in Educational Building Has Been Marked." *Architectural Record* 81: BT 2; April 1937.
579. SHIRE, A. C. "Modern Materials and Methods of Construction for School Building." *American School and University, 1938.* New York: American School Publishing Corp., 1938. p. 37-41.
580. SMITH, HOWARD DWIGHT. "Ten Year Program of the Columbus, Ohio, Board of Education." *American School Board Journal* 78: 49-58; March 1929.
581. SPAIN, CHARLES L. "Economy and the Modern Curriculum." *Detroit Educational Bulletin* 16: 1-3; January-February 1933.
582. SYKES, EARL F. "A Modern Bibliography of School Design." *Architectural Record* 79: 487-97; June 1936.
583. WILSON, WILLIAM K. "Instruction Areas." *Architectural Record* 83: 152-57; May 1938.

Chapter XII. Court Decisions in the School Plant Field

584. BOS, BERT P. *A Digest of the Laws and Court Decisions Relating to the Use of School Property.* Doctor's thesis. New York: New York University, 1937.
585. BRODY, ALEXANDER. *The American State and Higher Education.* Washington, D. C.: American Council on Education (744 Jackson Place), 1935. 251 p.
586. BRODY, ALEXANDER. "Higher Education." *The Third Yearbook of School Law, 1935.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1935. Chapter 14, p. 112-17.
587. BRODY, ALEXANDER. "State and Municipal Institutions of Higher Education." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 17, p. 101-108.
588. BRODY, ALEXANDER. "State Institutions of Higher Education." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 14, p. 100-104.
589. BRODY, ALEXANDER. "State Institutions of Higher Education." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 14, p. 117-21.
590. CHAMBERS, M. M. "Liability for Life and Limb." *Nation's Schools* 18: 31-32; October 1936.
591. CHAMBERS, M. M. "Pupil Injury Liability." *Educational Law and Administration* 5: 120-21; October 1937.
592. CHAMBERS, M. M. "Tax Exemption of Educational Institutions." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 16, p. 128-37.
593. CHAMBERS, M. M. "What's A School Building?" *Nation's Schools* 19: 33-34; May 1937.
594. COOKE, DENNIS H. "The Tort Liability of School Districts and School Personnel." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 9, p. 62-67.

595. DAY, JAMES W. "School Contracts, Other Than for Teaching Services." *The Third Yearbook of School Law, 1935.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1935. Chapter 8, p. 61-66.
596. DAY, JAMES W. "School Contracts Other Than for Teaching Services." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 8, p. 57-62.
597. DAY, JAMES W. "School Contracts Other Than for Teaching Services." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 8, p. 71-76.
598. DAY, JAMES W. "School Contracts Other Than for Teaching." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council of Education, 1938. Chapter 11, p. 64-68.
599. ELLIOTT, EDWARD C., and CHAMBERS, M. M. *The Colleges and the Courts.* New York: Carnegie Foundation for the Advancement of Teaching, 1936. 563 p.
600. GARBER, LEE O. "Recent Court Decisions on Liability Insurance for School Buses." *Educational Law and Administration* 4: 109, 131; October 1936.
601. GARBER, LEE O. "Right of School Authorities to Insure with Mutual Companies." *Educational Law and Administration* 5: 43-44, 60; April 1937.
602. HODGDON, D. R. "Legal and Illegal Uses of School Buildings." *American School Board Journal* 95: 52, 87; July 1937.
603. KEYWORTH, M. R. "School District Debts." *The Third Yearbook of School Law, 1935.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1935. Chapter 10, p. 73-83.
604. LOCKENOUR, ROY M. "Private Schools and Colleges." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 15, p. 105-13.
605. LOCKENOUR, ROY M. "The Tort Liability of School Districts and School Personnel." *The Third Yearbook of School Law, 1935.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1935. Chapter 9, p. 67-72.
606. LOCKENOUR, ROY M. "The Tort Liability of School Districts and School Personnel." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 9, p. 77-83.
607. LOCKENOUR, ROY M. "The Tort Liability of School Districts and School Personnel." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 12, p. 68-75.
608. OWEN, RALPH DORNFELD. "School District Indebtedness." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 10, p. 68-74.
609. OWEN, RALPH DORNFELD. "School District Indebtedness." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 10, p. 84-91.
610. OWEN, RALPH DORNFELD. "School District Indebtedness." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 13, p. 76-84.
611. PUNKE, HAROLD H. "Collateral Uses of Public School Property." *Educational Law and Administration* 5: 14-15, 26, 28-29, 32; January 1937.
612. PUNKE, HAROLD H. *The Courts and Public School Property.* Chicago: University of Chicago Press, 1936. 313 p.
613. PUNKE, HAROLD H. "Federal Aid for Educational Projects." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 10, p. 58-64.
614. PUNKE, HAROLD H. "The Management and Control of School Property." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 7, p. 62-70.
615. SOHL, C. E. *State Control of the Location, Planning, and Erection of Public School Buildings.* Philadelphia: University of Pennsylvania, 1935. 373 p. ms.
616. SPENCER, CARLTON E. "Acquisition of Real Property by School Districts." *The Third Yearbook of School Law, 1935.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1935. Chapter 7, p. 56-60.
617. SPENCER, CARLTON E. "Private Schools and Colleges; Educational Trusts." *The Fifth Yearbook of School Law, 1937.* Washington, D. C.: American Council on Education, 1937. Chapter 15, p. 122-27.

618. SPENCER, CARLTON E. "Private Schools and Colleges; Educational Trusts; Taxation." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 18, p. 108-17.
619. TIETZ, JULIUS B. "The Acquisition, Use, and Control of Real Property." *The Fourth Yearbook of School Law, 1936.* Washington, D. C.: M. M. Chambers (744 Jackson Place), 1936. Chapter 7, p. 53-56.
620. WALKER, WILLIAM J. "Power of School Boards to Reject Lowest Contract Bids." *American School Board Journal* 94: 38-40; April 1937.
621. WELTZIN, J. FREDERICK. "The Management and Control of School Property." *The Sixth Yearbook of School Law, 1938.* Washington, D. C.: American Council on Education, 1938. Chapter 9, p. 53-57.
622. WERNER, J. C. "Litigation Concerning School Fire Insurance." *American School Board Journal* 91: 40-41; December 1935.
623. WERNER, J. C. "State Laws on School Insurance." *Nation's Schools* 15: 33-34; February 1935.

Chapter XIII. Status of Research in the School Plant Field

624. FREEMAN, FRANK N. "Foreword." *Review of Educational Research* 2: 344; December 1932.
625. HAMOR, WILLIAM A. "Industrial Research Progress Here and Abroad During 1937." *Industrial and Engineering Chemistry* 16: January 10, 1938.
626. HOLY, T. C. "Needed Research in the Field of School Buildings and Equipment." *Review of Educational Research* 5: 406-11, 439; October 1935.
627. MARSH, C. S., editor. *American Universities and Colleges.* Third edition. Washington, D. C.: American Council on Education, 1936. p. 77-78.
628. NEW YORK COMMISSION ON VENTILATION. *School Ventilation, Principles, and Practices.* New York: Teachers College, Columbia University, 1931. 73 p.
629. RATCLIFFE, ELLA B. *Scholarships and Fellowships.* U. S. Dept. of the Interior, Office of Education, Bulletin, 1936, No. 10. Washington, D. C.: Government Printing Office, 1936. 117 p.
630. RUSSELL, JOHN DALE, chairman. *A Proposal for the Development of a System of Fellowships in Education for the Improvement of the Selection and Training of Workers in Educational Research.* Proposal submitted by a special subcommittee to the Problems and Plans Committee of the American Council on Education. Washington, D. C.: American Council on Education, October 1936. (Mimeo.)
631. U. S. CONGRESS. *Agricultural Adjustment Act of 1938.* Public—No. 430—75th Congress. Chapter 30—3d Session. H. R. 8505. 1938. 52 p.
632. U. S. DEPARTMENT OF AGRICULTURE. *Report of the Secretary of Agriculture, 1934.* Washington, D. C.: Government Printing Office, 1934. 119 p.
633. U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF EXPERIMENT STATIONS. *Experiment Station Record* 77: 433; October 1937.
634. ZOOK, GEORGE F. *The President's Annual Report 1937-38.* Washington, D. C.: American Council on Education, 1938. 42 p.

Index to Vol. VIII, No. 4, October 1938

References in this Index are to the beginning of chapters and their subdivisions, and to the first allusion in running (perhaps intermittent) discussions. One should scan several pages following the one cited.